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## ABSTRACT

This is one of eighteen sets of individualized mathematics problems developed by the Oregon Vo-Tech Math Project. Each of these problem packages is organized around a mathematical topic and contains problems related to diverse vocations. Solutions are provided for all problems. This volume contains problems involving ratio and proportion. Some problems involve implicit use of trigonometric relations (although the trigonometric functions are not named). Problems are drawn from nineteen vocational areas: forestry, forest products, wood products, food processing, marketing, auto mechanics, diesel mechanics, industrial mechanics, aviation mechanics, nursing, clerical work, wastewater technology, agriculture, fire and police science, industrial, electrical and hydraulics technology, electronics, machine tools, construction, and drafting. (SD)

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# INDIVIDUALIZED LEARNING SYSTEMS

Individualized Math Problems in

## Ratio and Proportion

Oregon Vo-Tech Mathematics Problem Sets

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Individualized Learning Systems

## MATHEMATICS

**Ratio and Proportion**  
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RATIO & PROPORTION  
Level II

A. Problems with Solutions

Retrieval - Dissemination Forestry  
Oregon Board of Education Center  
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1. The first shift on a fire builds 40 chains of fire line in 8 hours.  
If the second shift works at the same rate how long will it take  
them to build an additional 34 chains of fire line?

Solution:  $\frac{40 \text{ chains}}{8 \text{ hours}} = \frac{34 \text{ chains}}{N \text{ hours}}$

$$(40 \text{ chains}) (N \text{ hrs}) = (34 \text{ chains}) (8 \text{ hrs})$$

$$(N \text{ hrs}) = \frac{(34 \text{ chains}) (8 \text{ hrs})}{40 \text{ chains}}$$

$$N = 6.8 \text{ hrs}$$

2. A forest service pickup that takes 15 gallons of gasoline to  
travel 190 miles will require how many gallons to travel 250 miles?

Solution:  $\frac{15 \text{ gallons}}{190 \text{ miles}} = \frac{N \text{ gallons}}{250 \text{ miles}}$

$$(15 \text{ gallons}) (250 \text{ miles}) = (190 \text{ miles}) (N \text{ gallons})$$

$$\frac{(15 \text{ gallons}) (250 \text{ miles})}{190 \text{ miles}} = N \text{ gallons}$$

$$19.74 \text{ gallons} = N$$

3. The scale on a map in 1 inch = 100 feet. If two stations are  
known to be 1 mile apart, what would their distance be on the  
map?

Solution: Since 5280 ft = mile

$$\frac{1 \text{ in.}}{100 \text{ ft}} = \frac{N \text{ in.}}{5,280 \text{ ft}}$$

$$(100 \text{ ft}) (N \text{ in}) = (5280 \text{ ft}) (1 \text{ in})$$

$$N \text{ in} = \frac{(5280 \text{ ft}) (1 \text{ in})}{100 \text{ ft}}$$

$$N = 52.80 \text{ in}$$



RATIO AND PROPORTION  
Level II

Forestry

A. Problems with Solutions (continued)

4. With a 10 mph wind a ponderosa pine seed falling from a cone 100ft. above the ground will travel 290 ft, while a sugar pine seed under similar conditions will travel only 170 ft. If a 25mi/hr wind will carry a ponderosa pine seed 750 ft, how far would you expect it to carry the sugar pine seed?

Solution: The only numbers we need to be concerned with are the distances the seeds travel. Our proportion is:

$$\frac{290\text{ft}}{750\text{ ft}} = \frac{170\text{ft}}{x\text{ ft}}$$

$$(290\text{ft})(x\text{ ft}) = (750\text{ft})(170\text{ft})$$

$$x\text{ ft} = \frac{(750\text{ft})(170\text{ft})}{290\text{ ft}} = 439.65\text{ ft.}$$

5. Determine the number of feet per inch on aerial photographs whose scales are:

- a) 1:10000
- b) 1:15600
- c) 1:20400
- d) 1:25000

Solution:

- a)  $\frac{1}{10,000}$  means 1 inch on the photo represents 10,000 inches on the ground, so,  $\frac{10,000\text{in}}{12\text{ in/ft}} = 833.3\text{ ft.}$   
or, 1 inch also represents 833.3 ft.

c)  $\frac{20,400\text{ in}}{12\text{ in/ft}} = 1700\text{ ft}$

d)  $\frac{25,000\text{ in}}{12\text{ in/ft}} = 2083.33\text{ ft.}$

A. Problems with Solutions (continued)

6. In aerial photography the height of tall objects near the edge of a large scale vertical photograph can be determined by the following proportion:

$$\frac{H}{A} = \frac{D}{R} \text{ where, } H = \text{height of the object (ft)}$$

D = length of displaced image (in)

R = radial distance from the radius to the top of the displaced image.

A = altitude above the base of the object (ft)

determine the height of an object on an aerial photograph where:

a)  $D = .21 \text{ in, } R = 2.18 \text{ in, } A = 3000 \text{ ft.}$

b)  $D = .09 \text{ in, } R = 2.84 \text{ in, } A = 4000 \text{ ft.}$

Solution:

$$\text{a) } \frac{H}{3000\text{ft}} = \frac{.21 \text{ in}}{2.18 \text{ in}} \text{ or } H = \left( \frac{.21\text{in}}{2.18\text{in}} \right) (3000\text{ft}) = 289\text{ft.}$$

$$\text{b) } \frac{H}{4000 \text{ ft}} = \frac{.09 \text{ in}}{2.84 \text{ in}} \text{ or } H = \left( \frac{.09\text{in}}{2.84\text{in}} \right) (4000\text{ft}) = 127\text{ft.}$$

## Forestry

7. A fire crew has built 22 chains of fire line in the first  $5 \frac{1}{2}$  hours on their shift. If they can continue at the same pace how much more fire line can they build on the remaining  $4 \frac{1}{2}$  hours of their shift?

8. If a 20 acre forest service campground can accomodate 35 camp sites, how many additional acres will be needed to expand to handle another 18 campsites?

9. A logging truck which requires 23 gallons of gasoline to travel 175 miles will be able to travel how far on 35 gallons of gasoline?



10. By the end of the fifth month of the fiscal year the Deschutes National Forest will have sold 74.3 million board feet of timber. How much timber can we project that they will sell in the remaining seven months of the fiscal year?

11. If the Deschutes National Forest predicts that they will sell 130.5 million board feet of Ponderosa Pine and Douglas Fir in the next fiscal year, how many million board feet will they have sold at the end of the ninth month of the fiscal year?
12. The Forest Service just obtained an additional 28 acres next to an existing 50 acre campground which has 85 campsites. How many additional campsites can be constructed on the newly obtained land?

RATIO & PROPORTION  
Level II

Forestry

B. Problems without solutions.

13. If a 20mi/hr wind will carry a sugar pine seed 375 feet, how far would you expect it to carry a ponderosa pine seed?  
(see problem 4)
14. The Forest Service collected \$23,585 for slash disposal on 320 acres. At the same rate what would the amount be for slash disposal on a 295 acre plot?
15. On another slash removal job the Forest Service collected \$18,876 for work on a 230 acre plot. How many acres of slash removal work could be done at this rate if \$63,000 was included in the budget for slash removal work?

B. Problems without solutions

16. Over the next 5 years a Forest Service study indicated that an additional 58 million acres will have been added to our wilderness preservation system. How many acres will have been added in the next year and  $\frac{1}{2}$ ?

17. The scale on a map is 1 inch = 50 feet. If two points are  $3\frac{1}{2}$  inches apart on the map, what is the actual distance between the two points?

18. If the scale on a map is 4 inches per mile how many feet would separate two locations that are  $2\frac{1}{2}$  inches apart on a map?

RATIO & PROPORTION  
Level II

Forestry

B. Problems without solutions.

19. Given the scale on a map is  $\frac{1}{2}$  inch = 5 miles. Two locations that are separated by  $2\frac{1}{4}$  inches on the map are actually how far apart?

20. Determine the number of chains per inch on aerial photographs whose scales are:

- a) 1:7920
- b) 1:10000
- c) 1:18000
- d) 1:31,680

21. Determine the number of miles per inch on aerial photographs whose scales are:

- a) 1:8400
- b) 1:12000
- c) 1:19200
- d) 1:22800



B. Problems without solutions.

22. In aerial photography the heights of tall objects near the edge of a large scale vertical photograph can be determined by the following proportion:

$$\frac{H}{A} = \frac{D}{R} \text{ where:}$$

H = height of object in feet  
D = length of the displaced image in inches  
R = radial distance from the nadir (point at which photograph is pierced by a vertical line extended from the ground through the center of the camera lens) to the top of the displaced image.  
A = altitude above the base of the object in feet.

Determine the height of an object where:

D = .18 inches, R = 2.34 inches, A = 3000 feet.

23. Determine the height of an object where:

D = .10 inches, R = 2.91 inches, A = 4000 feet

24. A tall redwood measures .28 inches on a photograph while the distance from the nadir is 3.00 inches. If the photograph was taken from 3600 ft., how tall is the redwood tree?

RATIO & PROPORTION  
Level II

Forestry

Complete solutions to 8 problems

$$7. \frac{22 \text{ chains}}{N \text{ chains}} = \frac{5 \frac{1}{2} \text{ hrs}}{4 \frac{1}{2} \text{ hrs}}$$

$$(5 \frac{1}{2} \text{ hrs}) (N \text{ chains}) = (22 \text{ chains}) (4 \frac{1}{2} \text{ hr})$$

$$N \text{ chains} = \frac{(22 \text{ chains}) (4 \frac{1}{2} \text{ hr})}{5 \frac{1}{2} \text{ hrs}}$$

$$= 18 \text{ chains}$$

$$8. \frac{20 \text{ acres}}{N \text{ acres}} = \frac{35 \text{ camps}}{18 \text{ camps}}$$

$$(35 \text{ camps}) (N \text{ acres}) = (18 \text{ camps}) (20 \text{ acres})$$

$$N \text{ acres} = \frac{(18 \text{ camps}) (20 \text{ acres})}{35 \text{ camps}}$$

$$= 10.28 \text{ acres}$$

$$9. \frac{23 \text{ gallons}}{175 \text{ miles}} = \frac{35 \text{ gallons}}{N \text{ miles}}$$

$$(23 \text{ gallons}) (N \text{ miles}) = (35 \text{ gallons}) (175 \text{ miles})$$

$$N \text{ miles} = \frac{(35 \text{ gallons}) (175 \text{ miles})}{23 \text{ gallons}}$$

$$N \text{ miles} = 266.3 \text{ miles}$$

$$10. \frac{74.3 \text{ MBF}}{N \text{ MBF}} = \frac{5 \text{ months}}{7 \text{ months}}$$

$$(5 \text{ months}) (N \text{ MBF}) = (7 \text{ months}) (74.3 \text{ MBF})$$

$$N \text{ MBF} = \frac{(7 \text{ months}) (74.3 \text{ MBF})}{(5 \text{ months})}$$

$$N \text{ MBF} = 104.02 \text{ MBF}$$

# RATIO & PROPORTION

## Level 2

### Complete Solutions to B Problems

#### Forestry

$$11. \quad \frac{138.5 \text{ MBF}}{N} = \frac{12 \text{ months}}{9 \text{ months}}$$

$$(N) (12 \text{ months}) = (138.5 \text{ MBF}) (9 \text{ months})$$

$$N = \frac{(138.5 \text{ MBF}) (9 \text{ months})}{12 \text{ months}} = 103.87 \text{ MBF}$$

$$12. \quad \frac{28 \text{ acres}}{50 \text{ acres}} = \frac{N}{85 \text{ camps}}$$

$$(N) (50 \text{ acres}) = (28 \text{ acres}) (85 \text{ camps})$$

$$N = \frac{(28 \text{ acres}) (85 \text{ camps})}{50 \text{ acres}}$$

$$N = 47.6 \text{ camps} \quad \text{or} \quad 47 \text{ camps}$$

$$13. \quad \frac{375 \text{ ft}}{170 \text{ ft}} = \frac{N}{290 \text{ ft}}$$

$$(N) (170 \text{ ft}) = (375 \text{ ft}) (290 \text{ ft})$$

$$N = \frac{(375 \text{ ft}) (290 \text{ ft})}{170 \text{ ft}}$$

$$N = 639.7 \text{ ft}$$

$$14. \quad \frac{\$23,585}{N} = \frac{320 \text{ acres}}{295 \text{ acres}}$$

$$(N) (320 \text{ acres}) = (\$23,585) (295 \text{ acres})$$

$$N = \frac{(\$23,585) (295 \text{ acres})}{320 \text{ acres}}$$

$$N = \$21,742.42$$

RATIO & PROPORTION  
Level II

Forestry

Complete solutions to B problems, continued.

$$15. \frac{\$18,876}{\$63,000} = \frac{230 \text{ acre}}{N \text{ acre}}$$

$$(N \text{ acres}) (\$18,876) = (\$63,000) (230 \text{ acre})$$

$$(N \text{ acres}) = \frac{(\$63,000) (230 \text{ acre})}{\$18,876}$$

$$N \text{ acres} = 767.64 \text{ acres}$$

$$16. \frac{5 \text{ yr}}{1.5 \text{ yr}} = \frac{58 \text{ million acres}}{N \text{ million acres}}$$

$$(5 \text{ yrs}) (N \text{ million acres}) = (58 \text{ million acres}) (1.5 \text{ yr})$$

$$(N \text{ million acres}) = \frac{(58 \text{ million acres}) (1.5 \text{ yr})}{5 \text{ yr}}$$

$$= 17.4 \text{ million acres}$$

$$17. \frac{1 \text{ in.}}{3.5 \text{ in}} = \frac{50 \text{ ft}}{N \text{ ft}}$$

$$(1 \text{ in}) (N \text{ ft}) = (50) (3.5 \text{ in})$$

$$N \text{ ft} = \frac{(50) (3.5 \text{ in})}{1 \text{ in}}$$

$$N \text{ ft} = 175 \text{ ft}$$

$$18. \frac{4 \text{ in}}{2 \frac{1}{2} \text{ in}} = \frac{5,280 \text{ ft}}{N \text{ ft}}$$

$$(4 \text{ in}) (N \text{ ft}) = (5,280 \text{ ft}) (2 \frac{1}{2} \text{ in})$$

$$N \text{ ft} = \frac{(5,280 \text{ ft}) (2 \frac{1}{2} \text{ in})}{4 \text{ in}}$$

$$N \text{ ft} = 3,300 \text{ ft}$$



RATIO & PROPORTION  
Level II

Forestry

Complete solutions to B problems

19. Solution:

$$\frac{1/2 \text{ in}}{2 \frac{1}{4} \text{ in}} = \frac{5 \text{ mi}}{N \text{ mi}}$$

$$(1/2 \text{ in}) (N \text{ mi}) = (5 \text{ mi}) (2 \frac{1}{4} \text{ in})$$

$$N \text{ mi} = \frac{(5 \text{ mi}) (2 \frac{1}{4} \text{ in})}{1/2 \text{ in}}$$

$$N \text{ mi} = 22.5 \text{ mi}$$

20. Solution:

a) 1 chain = 66 ft = 792 inches so,

$$\frac{7920 \text{ inches}}{792 \text{ inches/chain}} = 10 \text{ chains}$$

$$\text{b) } \frac{10,000 \text{ inches}}{792 \text{ inches/chain}} = 12.63 \text{ chains}$$

$$\text{c) } \frac{18,000 \text{ inches}}{792 \text{ inches/chain}} = 22.73 \text{ chains}$$

$$\text{d) } \frac{31,680 \text{ inches}}{792 \text{ inches/chain}} = 40 \text{ chains}$$

RATIO & PROPORTION  
Level III

Forestry

Complete solutions to B problems, continued.

21. Solution:

a) 1 mile = 5280 ft = 63,360 inches so,

$$\frac{8,400 \text{ inches}}{63,360 \text{ inches/mile}} = .13 \text{ miles}$$

b)  $\frac{12,000 \text{ inches}}{63,360 \text{ inches/mile}} = .19 \text{ miles}$

c)  $\frac{19,200 \text{ in}}{63,360 \text{ in / miles}} = .30 \text{ miles}$

d)  $\frac{22,800 \text{ in}}{63,360 \text{ in/ miles}} = .36 \text{ miles}$

22. Solution:

$$\frac{H}{3000\text{ft}} = \frac{.18 \text{ in}}{2.34 \text{ in}}$$
$$H = 230.77 \text{ ft}$$

23. Solution:

$$\frac{H}{2500 \text{ ft}} = \frac{.34 \text{ in}}{2.04 \text{ in}}$$
$$H = 416.67 \text{ ft}$$

24. Solution:

$$\frac{H}{3600 \text{ ft}} = \frac{.28 \text{ in}}{3.00 \text{ in}}$$
$$H = 336 \text{ ft.}$$

A. Problems with Solutions

1. A planimeter is used on an aerial photograph to determine the number of acre feet of water behind a dam. The scale of the photo is 20,000:1, in inches, and the average depth of the lake is known to be 57.3 ft. The planimeter reads 3.71 sq in. Determine the volume of water in acre feet. Note: There are 43,560 sq ft per acre.

Solution:

$$\frac{A}{(20,000 \text{ in})(20,000 \text{ in})} = \frac{3.71 \text{ sq in}}{1 \text{ sq in}}$$

$$\frac{(400,000,000 \text{ sq in})(3.71 \text{ sq in})}{1 \text{ sq in}}$$

$$A = (1,484,000,000 \text{ sq in}) \left( \frac{1 \text{ sq ft}}{144 \text{ sq in}} \right)$$

$$A = 10,305,556 \text{ sq ft}$$

Divide by 43,560 sq ft per acre

$$A = \frac{10,305,556 \text{ sq ft}}{43,560 \text{ sq ft/acre}} = 236.6 \text{ acres}$$

Multiply by the average depth in feet

$$\text{Volume} = (236.6 \text{ acres})(57.3 \text{ ft}) = 13,557.2 \text{ acre feet}$$

2. Corrections for elevation readings made with an aneroid barometer are accomplished by calibrating the instrument at a point of known elevation, then measuring and recording the elevation and the time of measurement at the desired stations and, finally, returning to the initial point (whose elevation is known) for a second reading of both elevation and time. The difference between the initial and final measurement of both elevation and time is used as a base for computing any error in the readings taken at the other stations.

The assumptions made are that any difference between the initial the final measurements is due entirely to air pressure changes and, further, that these changes were linear over the period of time between the measurements.

The following data was obtained with an aneroid barometer. The elevation at station A is known to be 2,000 ft. Find the corrected elevations at stations B, C, and D and the minimum length of road between stations A and D at a constant 5% grade.

RATIO AND PROPORTION  
Level 2

Forest Products

A. Problems with Solutions (continued)

| 2. | Station | Time       | Observed Elevation |
|----|---------|------------|--------------------|
|    | A       | 9:00 am    | 2,000 feet         |
|    | B       | 9:45 am    | 2,150 feet         |
|    | C       | 10:45 am   | 2,300 feet         |
|    | D       | 11:15 am   | 2,500 feet         |
|    | A       | 12:00 noon | 2,280 feet         |

Solution:

$$\frac{\text{Measurement time}}{\text{Total time}} = \frac{\text{Correction}}{\text{Difference in Station A elevation readings}}$$

For Station B,

$$\frac{45 \text{ min}}{180 \text{ min}} = \frac{\text{Correction}}{280 \text{ ft}}$$

$$\text{Correction} = \left( \frac{45}{180} \right) (280 \text{ ft}) = 70 \text{ ft}$$

Corrected elevation for Station B is 2,150 ft - 70 ft = 2,080 ft

For Station C,

$$\frac{105 \text{ min}}{180 \text{ min}} = \frac{\text{Correction}}{280 \text{ ft}}$$

$$\text{Correction} = \left( \frac{105}{180} \right) (280 \text{ ft}) = 163 \text{ ft}$$

Corrected elevation for Station C is 2,300 ft - 163 ft = 2,137 ft

For Station D,

$$\frac{135 \text{ min}}{180 \text{ min}} = \frac{\text{Correction}}{280 \text{ ft}}$$

$$\text{Correction} = \left( \frac{135}{180} \right) (280 \text{ ft}) = 210 \text{ ft}$$

Corrected elevation for Station D is 2,500 ft - 210 ft = 2,290 ft

Slope distance from A to D,

$$s = \frac{\text{Difference in elevation}}{\sin(\tan^{-1} 0.05)}$$

$$= \frac{290 \text{ ft}}{\sin 2.86^\circ}$$

$$= 5,812 \text{ ft}$$



A. Problems with Solutions (continued)

3. Calculate the area (in square miles) shown on an aerial photo which is 7" by 9" if the height of the plane was 10,000 ft and the focal length of the camera was 8 inches.

$$\text{Scale} = \frac{\text{Focal length}}{\text{Height}}$$

Solution:

$$\text{Scale} = \frac{8 \text{ in}}{10,000 \text{ ft}} = \frac{1 \text{ in}}{1,250 \text{ ft}}$$

Area equals length of photograph divided by scale times width of photograph divided by scale.

$$\begin{aligned} \text{Area} &= \left( \frac{7 \text{ in}}{1 \text{ in}/1,250 \text{ ft}} \right) \left( \frac{9 \text{ in}}{1 \text{ in}/1,250 \text{ ft}} \right) \\ &= (7)(1,250 \text{ ft})(9)(1,250 \text{ ft}) \\ &= 98,437,50 \text{ sq ft} \end{aligned}$$

Dividing each factor by 5,280 ft/mi

$$\text{Area} = \frac{98,437,500 \text{ sq ft}}{(5,280 \text{ ft/mi})(5,280 \text{ ft/mi})} = 3.53 \text{ sq mi}$$

4. Suppose you are asked to locate a road between two stations, A and B. The elevation of station A is known to be 1,100 ft. You calibrate your aneroid barometer at station A at 8:00 am and measure off the distance to station B which you determine to be a horizontal distance of 24 chains, 57 links. You read 1,270 ft on your barometer at station B at 9:47 am. You return to station A at 11:00 am and your barometer reads 1,027 feet at this time. Determine the difference in elevation between the two stations and the minimum grade of a road in percent to connect the two points.

Note: Corrections for elevation readings made with an aneroid barometer are accomplished by calibrating the instrument at a point of known elevation, then measuring and recording the elevation and the time of measurement at the desired stations and, finally, returning to the initial point (whose elevation is known) for a second reading of both elevation and time. The difference between the initial and final measurement of both elevation and time is used as a base for computing any error in the readings taken at the other stations. The assumptions made are that any difference between the initial and final measurement is due entirely to air pressure changes and, further, that these changes were linear over the period of time between the measurements.  
1 chain = 100 links = 66 ft.

RATIO AND PROPORTION  
Level 2

Forest Products

A. Problems with Solutions (continued)

4. Solution:

$$\begin{aligned}\text{Correction for elevation} &= \left( \frac{107 \text{ in}}{180 \text{ in}} \right) (1,100 \text{ ft} - 1,027 \text{ ft}) \\ &= (0.59) (73 \text{ ft}) \\ &= 43.4 \text{ ft}\end{aligned}$$

$$\begin{aligned}\text{Elevation of Station B} &= 1,270 \text{ ft} - 43.4 \text{ ft} \\ &= 1,226.6 \text{ ft}\end{aligned}$$

$$\begin{aligned}\text{Difference in elevation} &= 1,226.6 \text{ ft} - 1,100 \text{ ft} \\ &= 126.6 \text{ ft}\end{aligned}$$

$$\begin{aligned}\text{Horizontal distance} &= (24.57 \text{ chains}) (66 \text{ ft/chain}) \\ &= 1,621.6 \text{ ft}\end{aligned}$$

$$\begin{aligned}\text{Percent grade} &= \left( \frac{126.6 \text{ ft}}{1,621.6 \text{ ft}} \right) (100) \\ &= 7.8\% \\ &\approx 8\%\end{aligned}$$

B. Problems without Solutions

5. A line on an aerial photo with an RF of 10,000 measures 0.35 mm wide. Which of the following does it most likely represent? Show your calculations.

$$\text{Actual width} = (\text{line width}) \left( \frac{1 \text{ meter}}{1,000 \text{ mm}} \right) (\text{RF})$$

- a) Path                      b) One-lane road                      c) Two-lane highway  
d) Three-lane highway

6. An aerial photograph was taken at an altitude of 15,000 ft above mean sea level over a land surface elevation of 1,250 ft. The focal length of the camera is 8". Determine the RF of this photograph.

B. Problems without Solutions (continued)

7. An aerial photographer is required to obtain photographs with a scale of 4 inches per mile. Determine the height above mean sea level he must fly if the average elevation of the land is 2,000 ft and the focal length of the camera is 8.25 in.
  
8. A man uses the shadow method to estimate the height of a tree. The man is 6 feet tall and his shadow measures  $7 \frac{1}{2}$  ft when the length of the shadow cast by the tree is 227 ft. Both shadows are on level ground. Determine the height of the tree.
  
9. On a map whose scale is 1 in = 400 ft the distance between adjacent contours is 0.37 in and the contour interval is 50 ft.
  - a) Determine the % slope.
  - b) On this same map what would be the distance between contour lines if the slope were 37%?

B. Problems without Solutions (continued)

10. A planimeter is used in scaling an area on an aerial photograph. The scale of the photograph is 20,000:1. Determine the number of acres if the planimeter reading is 3.96 square inches.

11. Calculate the area (in acres) covered by a 7" by 9" negative if the focal length of the aerial camera was 10 inches and the height of the plane was 12,000 ft.

$$\text{Scale} = \frac{\text{Focal length}}{\text{Height}}$$

12. A stream has an average width of 3.6 mm on an aerial photo with a scale of 1 to 12,000. How many inches wide would the stream appear on a print which had a scale of 1 in = 300 ft.



B. Problems without Solutions (continued)

13. Aerial application of DDT mixed with diesel fuel has been used to control past infestations of the tussock moth. Each gallon of the mixture contains  $11/16$  pounds of DDT and weighs 7 lb 15 oz. Determine the number of pounds of DDT in a 20,000 pound plane load of the solution.
  
  
  
  
  
  
  
  
  
  
14. A spur road in a logging area is 500 feet long and leads to a landing which is circular in shape and 300 feet in diameter. On an aerial photo with a scale of 1:20,000 what would be the size of these images? i.e., the "length of the road" and the "diameter of the landing".
  
  
  
  
  
  
  
  
  
  
15. The Federal Government pays interest on an 'exact rate' of 365 days per year. Private industry pays interest based on a 360 day or "Banker's Year". Which system costs the least for a given amount of money borrowed for the same time and interest rate? Explain your answer.

**RATIO AND PROPORTION**  
**Level 2**

**Forest Products**

**B. Problems without Solutions (continued)**

16. The Federal Government pays interest on a basis of a 365 day year. Private industry pays interest on a basis of a 360 day or "Banker's Year". a) How much interest will the federal government pay on \$750,000 borrowed at  $6\frac{1}{2}\%$  for 225 days? b) The Bechtel Corporation borrowed \$85,000 from the National Exchange Bank for 37 days at 7%. How much interest did the corporation pay?

# RATIO AND PROPORTION

## Forest Products

### Level 2

#### Complete Solutions to B problems

$$\begin{aligned} 5. \quad \text{Actual width} &= (0.35 \text{ in}) \left( \frac{1 \text{ meter}}{1,000 \text{ mm}} \right) (10,000) \\ &= 3.5 \text{ meters} \\ &= 11.5 \text{ ft} \end{aligned}$$

Therefore the line probably represents a one-lane road.

$$\begin{aligned} 6. \quad \text{RF} &= \frac{\text{focal length, in}}{(\text{altitude, ft}) (12 \text{ in/ft})} \\ &= \frac{8.25 \text{ in}}{(13,750 \text{ ft}) (12 \text{ in/ft})} = \frac{1}{20,000} \end{aligned}$$

$$\begin{aligned} 7. \quad \frac{4 \text{ in}}{(5,280 \text{ ft})} &= \frac{8.25 \text{ in}}{\text{Height, ft}} \\ \text{Height} &= \frac{(8.25 \text{ in}) (5,280 \text{ ft})}{4 \text{ in}} \\ &= 10,890 \text{ ft} \end{aligned}$$

$$\text{Altitude} = 2,000 \text{ ft} + 10,890 \text{ ft} = 12,890 \text{ ft}$$

$$\begin{aligned} 8. \quad \frac{\text{Man's height}}{\text{Man's shadow}} &= \frac{\text{Tree's height}}{\text{Tree's shadow}} \\ \frac{6 \text{ ft}}{7.5 \text{ ft}} &= \frac{h}{227 \text{ ft}} \\ h &= \frac{(6 \text{ ft}) (227 \text{ ft})}{7.5 \text{ ft}} = 181.6 \text{ ft} \end{aligned}$$

$$\begin{aligned} 9. \quad \text{a) Percent slope} &= \left( \frac{50 \text{ ft}}{(0.36 \text{ in}) (400 \text{ ft/in})} \right) (100) \\ &= 33.8\% \end{aligned}$$

$$\begin{aligned} \text{b) Distance} &= \frac{\text{Contour interval}}{37\%} = \frac{50 \text{ ft}}{0.37} = 135 \text{ ft} \\ \text{Distance on map} &= \frac{135 \text{ ft}}{400 \text{ ft/in}} = 0.338 \text{ in} \end{aligned}$$

# RATIO AND PROPORTION

## Level 2

### Complete Solutions to B Problems (continued)

#### Forest Products

10. Let A be the area measured

$$\frac{A}{(20,00 \text{ in})^2} = \frac{3.96 \text{ in}^2}{1 \text{ sq in}}$$

$$A = (400,000,000 \text{ sq in}) (3.96) \\ = 1,584,000,000 \text{ sq in}$$

$$= \frac{1,584,000,000 \text{ sq in}}{144 \text{ sq in/sq ft}}$$

$$= 11,000,000 \text{ sq ft}$$

Dividing by 43,560 sq ft per acre

$$A = \frac{11,000,000 \text{ sq ft}}{43,560 \text{ sq ft/acre}} = 252.5 \text{ acres}$$

11. Scale =  $\frac{10 \text{ in}}{12,000 \text{ ft}} = \frac{1 \text{ in}}{1,200 \text{ ft}}$

$$\text{Area} = \left( \frac{7 \text{ in}}{1 \text{ in}/1,200 \text{ ft}} \right) \left( \frac{9 \text{ in}}{1 \text{ in}/1,200 \text{ ft}} \right)$$

$$= (7) (1,200 \text{ ft}) (9) (1,200 \text{ ft})$$

$$= (8,400 \text{ ft}) (10,800 \text{ ft})$$

$$= 90,720,000 \text{ sq ft}$$

Dividing by 43,560 sq ft per acre

$$\text{Area} = \frac{90,720,000 \text{ sq ft}}{43,560 \text{ sq ft/acre}} = 2,082.6 \text{ acres}$$

12. Width of stream =  $(3.6 \text{ mm}) \left( \frac{1 \text{ meter}}{1,000 \text{ mm}} \right) (12,000)$

$$= 43.2 \text{ meters}$$

$$= 4,320 \text{ mm}$$

$$= (4,320 \text{ mm}) (0.39 \text{ in/mm}) (0.8 \text{ ft/in})$$

$$= 140.4 \text{ ft}$$

$$\text{Width on photo} = \frac{140.4 \text{ ft}}{300 \text{ ft/in}}$$

$$= 0.472 \text{ in}$$



# RATIO AND PROPORTION

Forest Products

## Level 2

### Complete Solutions to B Problems (continued)

13.  $X$  = pounds of DDT in plane load

$$\frac{11/16 \text{ lb}}{7 \text{ } 15/16 \text{ lb}} = \frac{X}{20,000 \text{ lb}}$$

$$X = \frac{(20,000 \text{ lb})(11/16)}{7 \text{ } 15/16} = 1,732 \text{ lb}$$

14.  $\frac{1 \text{ in}}{20,000 \text{ ft}} = \frac{\text{length of road}}{500 \text{ ft}}$

$$\text{Length of road} = \frac{500 \text{ ft}}{20,000 \text{ ft/in}} = 0.3 \text{ in}$$

$$\text{Diameter of landing} = \left( \frac{300 \text{ ft}}{500 \text{ ft}} \right) (0.3 \text{ in}) = 0.18 \text{ in}$$

15. The interest,  $I$ , equals the principal times the rate per year times the time in years in either case, that is,  $I = Prt$ .

However, the time in years is  $\frac{\# \text{ days}}{360}$  for the Banker's Year and

$\frac{\# \text{ days}}{365}$  for the exact year, hence the Federal Government pays

less interest since  $\frac{t}{365}$  is less than  $\frac{t}{360}$ . The interest the

government pays is  $\frac{360}{365}$  or 98.6% of the amount paid by private

industry.

16. a)  $I = Prt$

$$= (\$750,000) \left( \frac{6.5}{100} \right) \left( \frac{225}{365} \right)$$

$$= \$30,051.37$$

- b)  $I = Prt$

$$= (\$85,000) \left( \frac{7}{100} \right) \left( \frac{37}{360} \right)$$

$$= \$611.53$$

RATIO & PERCENT  
Level II

Wood Products

B. Problems without solutions.

1. Methanol is converted into formaldehyde for use in the manufacture of hardboard. 161,640 pounds of formaldehyde was obtained from 10,421 gallons of methanol.

a) Find the decimal to the nearest hundredth for the ratio of formaldehyde to methanol. (lbs. of formaldehyde per gal. of methanol).

b) Find the percent of yield for the result of (a) compared to expected standard of 16.80 pounds per gallon.

$$\% \text{ yield} = \left( \frac{\text{Produced amount}}{\text{Standard amount}} \right) \times 100$$

Definitions: Hardboard -- wood chip fibers combined with chemicals and pressed into a solid panel.

Methanol -- poisonous liquid alcohol used in the synthesis of other chemicals.

Formaldehyde-- chemical used in making resin which holds wood chip fibers together in hardboard.

# RATIO & PERCENT

## Wood Products

Complete solutions to B problems.

$$1. \ a) \ \frac{161,640 \text{ pounds}}{10,421 \text{ gallons}} = 15.51 \text{ lbs/gal}$$

$$b) \ \% \text{ yield} = \left( \frac{\text{produced amount}}{\text{standard amount}} \right) \times 100$$

$$= \frac{15.51 \text{ lbs/gal}}{16.8 \text{ lbs/gal}}$$

$$= 92.32\%$$

RATIO AND PROPORTION  
Level 1

Food Processing

A. Problems with Solutions

1. Brine weighs 8.42 lbs per gallon. 7,500 gallons of brine is dumped into a redwood tank and equal weight of fresh cherries is added for the first brining step. How many pounds of fresh cherries should be added to this tank?

Solution:

$$\text{Cherries} = (7,500 \text{ gals})(8.42 \text{ lbs/gal}) = 63,150 \text{ lbs}$$

2. DEFINITIONS: In the case of fruit packed with a liquid packing media, the fruit content can best be determined by periodically checking containers prior to the addition of syrup. Generally, the fruit is added to the container and then passed beneath a syruer which adds a measured quantity of syrup.

PROBLEM: If frozen raspberries are being packed in 10 pound cans to a declared ratio of 4 parts fruit and 1 part syrup, each container should have a put-in fruit weight of \_\_\_\_\_ pounds.

Solution:

$$\text{Fruit} = (4/5)(10 \text{ lbs}) = 8 \text{ lbs}$$

3. In a continuous operation packing a declared 3 to 1 fruit ratio in 30 pound cans, 1,200 pounds of sugar were used for 150 cans. Is your packer complying with the declared 3 to 1 ratio?

Solution:

$$\text{Finished product} = (150 \text{ cans})(30 \text{ lbs/can}) = 4,500 \text{ lbs}$$

$$\text{Fruit} = 4,500 \text{ lbs} - 1,200 \text{ lbs} = 3,300 \text{ lbs}$$

$$\text{Ratio} = \frac{3,300 \text{ lbs}}{1,200 \text{ lbs}} = 2.75$$

The packer is not complying with the 3 to 1 ratio; there is too much sugar in this pack.



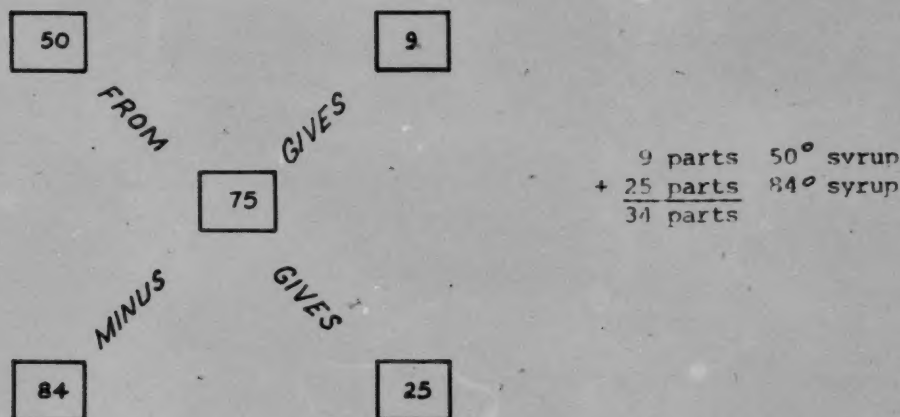
A. Problems with Solutions (continued)

4. Use a Pearson Square to produce a 1000 gallons 75° B syrup from 50° B and 84° B syrup.

DEFINITION: ALLIGATION ALTERNATE is a method by which we may calculate the number of parts of two or more components of a given strength when they are to be mixed to prepare a mixture of desired strength. A final proportion permits us to translate relative parts to any specific denomination. The strength of a mixture must lie somewhere between the strengths of its components--that is, the mixture must be somewhat stronger than its weakest component and somewhat weaker than its strongest; and, as already indicated, the strength of the mixture is always a "weighted" average: it lies nearer to that of its weaker or stronger components depending upon the relative amounts involved.

This "weighted" average can be found by means of an extremely simple scheme, as illustrated in the diagram below.

Solution:



$$\text{Ratio} = \frac{1000 \text{ gals}}{34 \text{ parts}} = 29.4 \text{ gals/part}$$

$$50^\circ \text{ B syrup} = (9 \text{ parts})(29.4 \text{ gals/part}) = 264.6 \text{ gals}$$

$$84^\circ \text{ B syrup} = (25 \text{ parts})(29.4 \text{ gals/part}) = 735.4 \text{ gals}$$

B. Problems without Solutions

5. DEFINITION: A 3 x 1 pack means 3 parts by weight of fruit and 1 part by weight of dry sugar.

PROBLEM: If the pack is declared as 3 x 1, (3 parts fruit and 1 part sugar), then in a 400 lb sample the content is  $\frac{3}{4}$  fruit and  $\frac{1}{4}$  sugar. What are the weights of the fruit and the sugar?

6. A carload of frozen fruit is packed to a declared ratio 4 x 1. 1,600 containers of 30 pounds each required 9,500 pounds of sugar. Is this packer complying to the declared ratio? (A slight excess of fruit in a declared ratio is considered satisfactory.)

7. DEFINITION: A 3 x 1 pack means 3 parts by weight of fruit and 1 part by weight of dry sugar. For example, the proportion of ingredients in a 400 pound barrel of frozen berries with different declared proportions of fruit and sugar is calculated as follows: If the declared is 5 x 1, (5 parts fruit 1 part sugar), then  $\frac{5}{6}$  of the contents is fruit and  $\frac{1}{6}$  is sugar.

PROBLEM: (a) In a 400 pound 5 x 1, what is the weight of the fruit?

(b) In a 400 pound 5 x 1, what is the weight of the sugar?

B. Problems without Solutions (continued)

8. Standardization of a silver nitrate solution used in salt content determination. Calculate the normality of the  $\text{Ag NO}_3$  solution by the formula:  $V_1 N_1 = V_2 N_2$ . 35.00 ml of a standard (exactly 0.1N) Na Cl (salt) solution requires 34.20 ml of  $\text{Ag NO}_3$  to reach the end point.

DEFINITION: End point is indicated by a change in color or appearance and shows the solutions to be chemically equal.

9. Use the reagent  $\text{Ag NO}_3$  to multiply the actual liter by a factor to convert to equivalent 0.1 Normal strength. Calculate the normality of the  $\text{Ag NO}_3$  reagent solution by the formula  $V_1 N_1 = V_2 N_2$ . 40.21 ml of 0.1023 Normal  $\text{Ag NO}_3$  is used in titration. The Normality of the standard solution was exactly 0.100 Normal.

DEFINITION

Titration: the operation of analyzing an unknown solution by means of a standard solution.

10. Your packer is declaring a 5 x 1 ratio. Over a 5 minute period, 400 pounds of sugar were used in packing 50 containers of fruit in 50 pound cans of a specified 5 x 1 ratio. Is the packer complying with his declared 5 x 1 ratio?

DEFINITION: A packer is complying if the fruit slightly exceeds and the sugar is less than the declared ratio.

B. Problems without Solutions (continued)

11. How many milliliters of 0.010 normal HCL can be made from 100.0 ml HCL of a 0.10 normal HCL? Remember that  $N_1 V_1 = N_2 V_2$  where  $N$  = normality and  $V$  = volume.

12. Sulfur Dioxide Determination

Procedure:

1. Fill a burette with 0.1N Iodine solution.
2. Put 5 ml of brine or filtered cherry juice in flask.
3. Add 20 ml of distilled water.
4. Add 1 ml of a 1% starch solution.
5. Add Iodine, drop by drop, counting drops until mixture turns blue or purple.

Calculations: Each ml of Iodine used corresponds to 640 parts per million of sulfur dioxide. There are 20 drops to each ml so each drop of Iodine is equal to 32 parts per million of  $SO_2$ . Total parts per million is the number of drops Iodine times 32.

Problem: 19 ml and 19 drops of Iodine turned the brine purple.

- (a) What was the parts per million of  $SO_2$ ?
- (b) What was the percent of  $SO_2$ ?



B. Problems without Solutions (continued)

13. In a representative sample of 10 g of beef there was 1.9 grams of fat. How many pounds of fat would there be in a 590 pound carcass?

14. If the producer has decided that \$49.00 per hundredweight is his minimum asking price, how much will he have to receive to compensate for a 8% shrink?

DEFINITION: The shrinkage refers to the weight loss encountered from the time the animals leave the feed lot until they are weighed over the scale at the market.

15. You are packing strawberries in 55 gallon drums that average 430 lbs to the drum. This pack (that is frozen) is 4 parts strawberries and 1 part sugar and is called a 4 to 1 pack. How many barrels of 4 to 1 strawberries are you expected to produce out of 49,130 pounds of strawberries processed? (Refer to table 10.)

B. Problems without Solutions (continued)

16. How would you make 1,000 gallons of 30° B with a ratio of 4 parts sucrose and 1 part corn syrup? Apply the Pearson square.

DEFINITIONS: Corn syrup = 78° Brix. Sucrose can be added to water to produce any desired Brix up to 100° B.

17. How much 20% cream would you need to add to 240 pounds of cottage cheese curd to produce a 5% fat? Curd is rated a 0% butterfat. Apply the Pearson Square.

B. Problems without Solutions (continued)

18. DEFINITION: Estimation of Fruit-Sugar Ratio Based Solely on Finished Product Examination.

This method consists of pulping the entire sample in a Waring Blender or other suitable laboratory mill and determining the soluble solids using the sucrose scale. The theoretical fruit-sugar ratio may be determined from the following formula:

$$R = \frac{100 - P_s}{P_s - F_s} \text{ in which}$$

R = ratio of fruit to sugar

P<sub>s</sub> = soluble solids of finished product

F<sub>s</sub> = soluble solids of in-going fruit or average soluble solids of authentic fruit.

Generally, the average value for authentic fruit will necessarily be used in the formula since on lot inspections the inspector will not know the actual solids of the in-going fruit. The following example will serve to illustrate the calculations for frozen strawberries.

P<sub>s</sub> (soluble solids of product) = 28.4

F<sub>s</sub> (soluble solids of authentic fruit) = 8.0

What is the ratio of fruit to sugar?

RATIO AND PROPORTION  
Level 1

Food Processing

Complete Solutions to B Problems

5. Fruit = (400 lbs) (3/4) = 300 lbs

Sugar = (400 lbs) (1/4) = 100 lbs

6. Total weight = (1,600 ~~containers~~) (30 lbs/container) = 48,000 lbs

Fruit = 48,000 lbs - 9,500 lbs = 38,500 lbs

Ratio =  $\frac{38,500 \text{ lbs}}{9,500 \text{ lbs}} = 4.05$  The packer is complying

7. (a) Fruit = (400 lbs) (5/6) = 333.33 lbs

(b) Sugar = (400 lbs) (1/6) = 66.67 lbs

Level 2

8.  $V_1 N_1 = V_2 N_2$

(35 ml) (0.1) = (34.2 ml) (x)

3.5 ml = 34.2 ml (x)

$x = \frac{3.5 \text{ ml}}{34.2 \text{ ml}} = 0.1023$  Therefore, the Normality of the Ag NO<sub>3</sub> reagent is 0.1023.

9. Equivalent 0.1 Normal Ag NO<sub>3</sub> = (40.21 ml) (1.023) = 41.13 ml

10. Finished product = (50 ~~cans~~) (50 lbs/can) = 2,500 lbs

Sugar = (2,500 lbs) (1/6) = 416.67 lbs

The packer is complying with slightly less sugar in the declared 5 x 1.

11.  $N_1 V_1 = N_2 V_2$   
(0.10) (100 ml) = (0.01) (V)

$V = \frac{(0.10) (100 \text{ ml})}{0.01} = 1,000 \text{ ml or 1 liter}$



RATIO AND PROPORTION  
Level 2

Food Processing

Complete Solutions to B Problems (continued)

12. (a)  $\text{PPM of SO}_2 = (640 \text{ PPM/ml})(19 \text{ ml}) + (32 \text{ PPM/drop})(19 \text{ drops})$   
 $= 12,160 \text{ PPM} + 608 \text{ PPM} = 12,768 \text{ PPM}$

(b)  $\text{Percent SO}_2 = \frac{12,768}{1,000,000} = 0.0128 = 1.28\%$

13.  $F = \text{pounds of fat}$

$$\frac{1.8 \text{ g}}{10 \text{ g}} = \frac{F}{590 \text{ lbs}}$$

$$F = \frac{1062 \text{ lbs}}{10} = 106.2 \text{ lbs}$$

14.  $P = \text{price per hundredweight needed to compensate for shrinkage}$

$$\frac{\$49.00}{0.92} = \frac{P}{1.00}$$

$$P = \frac{\$49.00}{0.92} = \$53.26$$

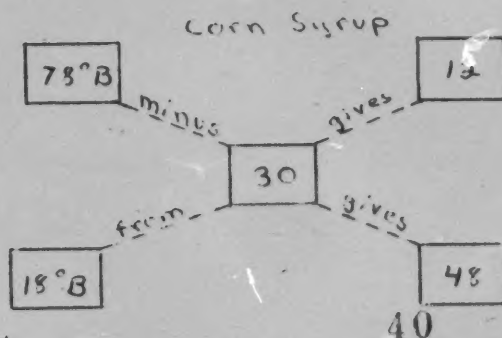
15. 7% loss is indicated for strawberries

$$\text{Strawberries produced} = (49,130 \text{ lbs})(0.93) = 45,690.9 \text{ lbs}$$

$$\text{Strawberries contained in pack} = \frac{45,690.9 \text{ lbs}}{4/5} = 57,113.6 \text{ lbs}$$

$$\text{Barrels} = \frac{57,113.6 \text{ lbs}}{430 \text{ lbs/barrel}} = 132.8 \text{ barrels}$$

16.



$$\begin{array}{r} 12 \text{ parts } 78^\circ \text{ B} \\ + 48 \text{ parts } 18^\circ \text{ B} \\ \hline 60 \text{ parts} \end{array}$$

RATIO AND PROPORTION  
Level 2

Food Processing

Complete Solutions to B Problems (continued)

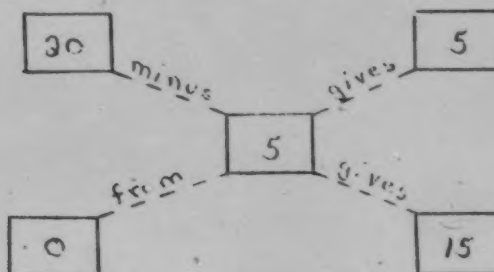
16. (continued)

$$\text{Ratio} = \frac{1,000 \text{ gals}}{60 \text{ parts}} = 16.667 \text{ gals/part}$$

$$\text{Corn syrup} = (16.667 \text{ gals/part})(12 \text{ parts}) = 200 \text{ gals}$$

$$\text{Sucrose} = (16.667 \text{ gals/part})(48 \text{ parts}) = 800 \text{ gals}$$

17.



x = cream needed

$$\frac{240 \text{ lbs}}{15} = \frac{x}{5}$$

$$15x = 1,200 \text{ lbs}$$

$$x = 80 \text{ lbs}$$

$$18. R = \frac{100 - 28.4}{28.4 - 8.0} = \frac{71.6}{20.4} = 3.50$$

RATIO AND PROPORTION  
Level 1

Marketing

A. Problems with Solutions

1. Three partners, Able, Baker and Carter have shares in the partnership of 1: 2: 7 respectively. If there is a profit of \$43,120, and it is to be distributed in proportion to share in the partnership, how much would each partner receive?

Solution:

There are  $1 + 2 + 7 = 10$  total shares in the partnership which is worth \$43,120

Able has  $\frac{1}{10} = \frac{x}{\$43,120}$  where x represents Able's share

Cross multiplying gives  $10x = \$43,120$

$$x = \$4,312$$

Baker has  $\frac{2}{10} = \frac{y}{\$43,120}$  where y represents Baker's share

Cross multiplying gives  $10y = \$86,240$

$$y = \$8,624$$

Carter has  $\frac{7}{10} = \frac{z}{\$43,120}$  where z represents Carter's share

Cross multiplying gives  $10z = \$301,840$

$$z = \$30,184$$

2. Brown invests \$4,400 and Black \$5,200 in a partnership. If profits are to be shared in the ratio that each partner's investment bears to the total amount invested, what return should Black receive if Brown's share of the profits is \$900?

Solution:

The ratio of the amounts should be the same as the ratio of profits. Let x = profit for Black. Then,

$$\frac{\$5,200}{\$4,400} = \frac{x}{\$900}$$

cross multiplying yields

$$4,680,000 = \$4,400x$$

$$\$1,063.64 = x$$

RATIO AND PROPORTION  
Level 1

Marketing

A. Problems with Solutions (continued)

3. A salted-nut mixture is made up of 3 pounds of cashews to 5 pounds of peanuts. How many pounds of each are needed to make 40 pounds of the mixture?

Solution:

Out of every 8 lbs of the mixture, 3 lbs are cashews. The remaining 5 lbs is peanuts.

The ratio of cashews to total weight then is  $\frac{3}{8}$ , and the ratio of peanuts to total weight is  $\frac{5}{8}$ . Since these ratios are constant, in 40 lbs of the mixture  $\frac{3}{8}$  or  $(\frac{3}{8})(40) = 15$  lbs would be cashews and  $\frac{5}{8}$  or  $(\frac{5}{8})(40) = 25$  lbs would be peanuts.

B. Problems without Solutions

4. A company had an earnings per share of stock of \$2.25 when its stock was selling for \$39/share. One month later the selling price had risen to \$42  $\frac{1}{2}$  per share. Compute the price/earnings ratios before and after the rise in price, assuming the earnings remain constant.
5. Cummings Company employs 48 factory workers. Four operations are performed. Compute the number of workers assigned to each operation.

|           | <u>Proportion of Total<br/>Work Performed</u> | <u>No. of Workers<br/>Assigned to Operation</u> |
|-----------|-----------------------------------------------|-------------------------------------------------|
| Cutting   | $\frac{1}{4}$                                 |                                                 |
| Fitting   | $\frac{1}{3}$                                 |                                                 |
| Bolting   | $\frac{3}{8}$                                 |                                                 |
| Finishing | $\frac{1}{24}$                                |                                                 |
|           | <u>1</u>                                      | <u>48</u>                                       |



RATIO AND PROPORTION  
Level 1

Marketing

B. Problems without Solutions (continued)

6. A and B are partners. How much does each receive if a profit of \$13,000 is divided in a ratio of 7 to 3 in favor of A?
7. Current ratio is defined as the ratio of a firm's current assets to current liabilities. Compute the current ratio for Kleg Corp. which has current assets of \$126,000 and current liabilities of \$91,500 (to nearest thousandth).
8. Dept B employees earned a yearly bonus of \$3,600. This amount will be distributed to the three employees in proportion to their annual salaries. Calculate each man's share.

| <u>Employee</u> | <u>Salary</u> | <u>Bonus</u>   |
|-----------------|---------------|----------------|
| Jones           | \$6,000       |                |
| Smith           | \$8,000       |                |
| Wilson          | \$10,000      |                |
|                 |               | <u>\$3,600</u> |

B. Problems without Solutions (continued)

9. Mr. Johnson invested \$39,600 in an apartment house earning a profit of \$4,250 yearly. He invests \$26,400 in another apartment house, expecting to earn a profit  $\frac{1}{3}$  larger in ratio to the amount invested. How much yearly profit does Mr. Johnson expect on the \$26,400 apartment house?
  
  
  
  
  
  
  
  
  
  
10. The ratio of net income to net worth (stockholder's equity) indicates the percent of return on invested capital. Compute the rate of return on equity for a firm with \$4,000 net income and \$29,000 stockholder's equity.
  
  
  
  
  
  
  
  
  
  
11. A gain of \$32,550 is to be divided between 3 partners in the ratios of  $\frac{1}{6}$ ,  $\frac{1}{3}$  and  $\frac{1}{2}$ . How should the profit be divided?
  
  
  
  
  
  
  
  
  
  
12. Two business partners divide their profits in a 1 to 4 ratio. Find each partner's share of a profit amounting to \$8,400.

B. Problems without Solutions (continued)

13. A building assessed at \$15,000 is billed \$475.50 for property taxes. A similar building next door, assessed at \$21,000, should be billed how much for taxes?

14. The ratio of a firm's net income to net sales gives a measure of the firm's percent of profit on sales. Compute the ratio for a firm with net income of \$4,000 and net sales of \$90,000.

RATIO AND PROPORTION  
Level 1

Marketing

Complete Solutions to B Problems

4.  $\frac{\text{Price}}{\text{Earnings}}$

$$\text{Before} = \frac{\$39}{\$2.25} = 17.33$$

$$\text{After} = \frac{\$42.50}{\$2.25} = 18.89$$

5. Cutting =  $(1/4)(48) = 12$

Fitting =  $(1/3)(48) = 16$

Bolting =  $(3/8)(48) = 18$

Finishing =  $(1/24)(48) = 2$

6. Total number of fractions =  $7 + 3 = 10$

A receives  $7/10$  and B receives  $3/10$

$$(7/10)(\$13,000) = \$9,100 = \underline{\text{A's share}}$$

$$(3/10)(\$13,000) = \$3,900 = \underline{\text{B's share}}$$

7.  $\frac{\text{Current Assets}}{\text{Current Liabilities}} = \frac{\$126,000}{\$91,500} = 1.377$

8. Total salary =  $\$6,000 + \$8,000 + \$10,000 = \$24,000$

$$\text{Jones will receive } \left( \frac{\$6,000}{\$24,000} \right) (\$3,600) = \$900$$

$$\text{Smith will receive } \left( \frac{\$8,000}{\$24,000} \right) (\$3,600) = \$1,200$$

$$\text{Wilson will receive } \left( \frac{\$10,000}{\$24,000} \right) (\$3,600) = \$1,500$$

9. Ratio of profit to amount invested in first apartment =  $\frac{\$4,250}{\$39,600}$



RATIO AND PROPORTION  
Level 1

Marketing

Complete Solutions to B Problems (continued)

9. (continued)

$$\begin{aligned}\text{For a } 1/3 \text{ increase} &= \left( \frac{\$4,250}{\$39,600} \right) (4/3) (\text{amount invested in second apartment}) \\ &= \left( \frac{\$4,250}{\$39,600} \right) (4/3) (\$26,400) = \$3,777.78\end{aligned}$$

$$\begin{aligned}10. \quad \frac{\text{Net income}}{\text{Net worth}} &= \left( \frac{\$4,000}{\$29,000} \right) (100) = \% \text{ return} \\ &= 13.79\%\end{aligned}$$

$$11. \quad (1/6) (\$32,550) = \$5,425$$

$$(1/3) (\$32,550) = \$10,850$$

$$(1/2) (\$32,550) = \$16,275$$

$$12. \quad \text{Total number of shares} = 1 + 4 = 5$$

$$\text{Amount to one partner} = (1/5) (\$8,400) = \$1,680$$

$$\text{Amount to other " } = (4/5) (\$8,400) = \$6,720$$

13. The ratio of property taxes to assessed value should be constant:

$$\frac{\$475.50}{\$15,000} = \frac{x}{\$21,000} \quad \text{where } x = \text{amount to be taxed on next building}$$

$$15,000x = \$9,985,500$$

$$x = \frac{\$9,985,500}{15,000}$$

$$x = \$665.70$$

$$14. \quad \text{Percent profit on sales} = \frac{\text{net income}}{\text{net sales}} = \frac{\$4,000}{\$90,000} (100) = 4.44\%$$

RATIO AND PROPORTION  
Level 1

Auto Mechanics

A. Problems with Solutions

1. The handle of a torque wrench is 16" long. If specifications call for a torque of 50 ft lbs, how much force must be applied on the torque wrench handle?

Solution:

F = force on torque wrench handle

$$\frac{16 \cancel{\text{in}}}{12 \cancel{\text{in}}} = \frac{50 \text{ ft lb}}{F}$$

$$16F = 600 \text{ ft lb}$$

$$F = 37.5 \text{ ft lb}$$

2. An automobile has a 13:1 lever advantage on the master cylinder. If a 20 lb force is applied to the pedal, what force will be put on the master cylinder?

Solution:

F = force on master cylinder

$$\frac{13}{1} = \frac{F}{20 \text{ lbs}} \quad F = 260 \text{ lbs}$$

3. If the dwell on a distributor is 30° and it is eight cylinder engine, what part of each minute are points in contact?

Solution:

The total contact degrees would be (30°)(8) or 240°. This equals 240/360 part of any time unit. Therefore, the points are in contact 2/3 of each minute or 40 seconds.

4. A fairly accurate rule of thumb on fuel consumption says that a vehicle at 70 MPH will use 25% more fuel than it would at 50 MPH. If a car made 15.7 miles per gallon at 70 MPH, what could it make at 50 MPH?

5. An untuned car uses more fuel for numerous reasons. One simple example is a fouled spark plug. On a 6 cylinder car the horsepower would go down  $\frac{1}{6}$  (actually more). If fuel consumption went up in indirect ratio, what would a car which usually made 19 miles per gallon, make?

6. The clutch linkage on a given vehicle has an overall advantage of 28:1. If the pressure plate applies a force of 837 lbs, how much force must the driver apply to release the clutch?

7. The starter drive gear has 7 teeth and the flywheel has 72 teeth. If the starter turns 4200 RPM, how fast does the engine turn?

RATIO AND PROPORTION  
Level 1

Auto Mechanics

B. Problems without Solutions (continued)

8. An 8 volt automotive coil has 300 turns of wire in the primary circuit. If the secondary voltage is 15,000, how many secondary turns are there in the coil?

9. A 1970 Buick with 455 displacement has a compression ratio of 10:1. The compression gauge shows 180 lbs pressure at cranking speed. What temperature would be present in the cylinder at compression if the outside temperature was 80°F? (Use -460°F as absolute temperature.)

10. At the beginning of a run a taxi has a tire pressure of 32 lb at 60°F. At the end of the run the tire pressure was 37.8 lb. What was the temperature of the tires? (-460°F = 0° R)

DEFINITIONS

F: Fahrenheit; R: Rankine (the absolute scale in Fahrenheit increments)



B. Problems without Solutions (continued)

11. A car weighing 2,892 lbs has a tire pressure of 28 lb at  $46^{\circ}\text{F}$ . After running for several hours, the tire temperature is  $146^{\circ}\text{F}$ . How many square inches of rubber are in contact with the road at this temperature?
12. An automobile is running on tire pressure of 28 lb at  $52^{\circ}\text{F}$ . What will the tire pressure be if the temperature raises to  $167^{\circ}\text{F}$ . ( $167^{\circ}\text{F} = 627^{\circ}\text{R}$ .)
13. The toe in on a 1973 Buick is  $1/8'' - 1/4''$ . The median setting is  $3/16''$ . If the measurement is taken at the bead of the tire, and the bead is  $21\ 3/4''$  diameter, how much would the tire drag inward in one mile? (Note this is not the reason for toe in and would not happen at normal speeds.)

RATIO AND PROPORTION  
Level 1

Auto Mechanics

B. Problems without Solutions (continued)

14. If a given automobile has a gear ratio of 2.27:1 in first gear and 1.43:1 in second gear, how many more RPM would the rear wheels have in second gear than in first? The engine RPM is 1500.
  
  
  
  
  
  
  
  
  
  
15. If a driver has a leverage advantage of 45.5:1, what force would be necessary to release a pressure plate with a total force of 980 pounds?
  
  
  
  
  
  
  
  
  
  
16. Given an engine with a clutch pedal ratio of 13" : 2", a throw out arm ratio of 7" : 3", clutch fingers with a 3" : 1" ratio, a pressure plate force of 980 lbs. What would be the greatest tension possible for an overcenter (assistance) spring if the spring is fastened 2" above the pivot pin in the clutch pedal?

B. Problems without Solutions (continued)

17. If the clutch pedal requires a force of 37 lbs without the overcenter spring and has a lever length of 11", the overcenter spring has a lever length of 2" and with the overcenter spring the force required is 13 lbs. How much force does the overcenter spring produce?
18. A brake pedal has a lever advantage of 13:1. The master cylinder has a bore of  $1 \frac{1}{8}$ " and is acting on a slave cylinder bore of  $2 \frac{15}{16}$ ". A force of 20 lbs has been applied to the brake pedal. If the coefficient of friction for the lining and the disc is 0.6, what stopping force does the brake have?
19. The distance from the rocker arm pivot center to the push rod center is  $\frac{3}{4}$ ". The distance to the stem center averages  $1 \frac{3}{8}$ ". If a  $\frac{7}{16}$ " valve travel is desired, what lift must the cam lobe produce? (The valve lash is 0.019".)

B. Problems without Solutions (continued)

20. What leverage advantage does the driver have if the clutch pedal ratio is 13" : 2", the throw out arm ratio is 7" : 3", and the clutch fingers have a ratio of 3" : 1"?
21. If the pressure in a cylinder is 200 lb at 180 F and the fuel ignition raises the temperature 1080 F, what would the pressure in the cylinder be? What would the effective pressure be? What would the effective force on the piston be if the bore is 3 1/4"? (Use -460 F as absolute zero.)
22. The pitch diameter of the crank pulley is 6 1/8", the alternator pulley has a pitch diameter of 2 1/4", and the pitch diameter of the fan pulley is 7 3/4". How fast does each pulley turn if the engine RPM is at 2700?



RATIO AND PROPORTION  
Level 1

Auto Mechanics

Complete Solutions to B Problems

4. The faster the speed, the less the mileage. At 70 MPH the gasoline consumption is 125%. At 50 MPH the consumption is 100% (It is an inverse ratio at that point.)

$$\frac{15.7 \text{ mi/gal}}{m} = \frac{1.00}{1.25}$$

$$m = 19.625 \text{ mi/gal}$$

$$m = 19.6 \text{ mi/gal}$$

5. 
$$\frac{19 \text{ mi/gal}}{m} = \frac{1.00}{0.8333}$$

$$m = 15.83 \text{ mi/gal}$$

6.  $F = \text{force}$

$$28 = \frac{837 \text{ lbs}}{F}$$

$$F = \frac{837 \text{ lbs}}{28} = 29.89 \text{ lbs}$$

7.  $R = \text{rpm of engine}$

$$\frac{72 \text{ teeth}}{4,200 \text{ RPM}} = \frac{7 \text{ teeth}}{R}$$

$$(72 \text{ teeth})R = (7 \text{ teeth})(4,200 \text{ RPM})$$

$$R = \frac{(7 \text{ teeth})(4,200 \text{ RPM})}{72 \text{ teeth}}$$

$$R = 408.33 \text{ RPM}$$

8.  $T = \text{turns in the secondary winding}$

$$\frac{8 \text{ volts}}{15,000 \text{ volts}} = \frac{300 \text{ turns}}{T}$$

$$8T = 4,500,000 \text{ turns}$$

$$T = 562,500 \text{ turns}$$

Complete Solutions to B Problems (continued)

9. C = temperature in the cylinder

$$\frac{460^{\circ} + 80^{\circ}}{(10)(14.7 \text{ lb})} = \frac{C}{180 \text{ lb}}$$

$$\frac{540^{\circ}}{147 \text{ lb}} = \frac{C}{180 \text{ lb}}$$

$$(147 \text{ lb})C = (180 \text{ lb})(540^{\circ})$$

$$C = \frac{(180 \text{ lb})(540^{\circ})}{147 \text{ lb}}$$

$$C = 661.22^{\circ} \text{ absolute temperature}$$

$$C = 201.22^{\circ}$$

10. T = tire temperature

$$\frac{32 \text{ PSI}}{37.8 \text{ PSI}} = \frac{(460 + 60)^{\circ} \text{ R}}{T}$$

$$32T = (37.8)(520^{\circ} \text{ R})$$

$$32T = 19,656^{\circ} \text{ R}$$

$$T = 614.25^{\circ} \text{ R}$$

$$614.25^{\circ} \text{ R} = 154.25^{\circ} \text{ F}$$

11. x = pressure inside tire

$$\frac{(460 + 46)^{\circ} \text{ R}}{(460 + 146)^{\circ} \text{ R}} = \frac{28 \text{ lb/sq in}}{x}$$

$$\frac{506^{\circ} \text{ R}}{606^{\circ} \text{ R}} = \frac{28 \text{ lb/sq in}}{x}$$

$$506x = 16968 \text{ lb/sq in}$$

$$x = 33.53 \text{ lb/sq in}$$

$$C = \text{rubber in contact with road } C = \frac{2892 \text{ lbs}}{33.53 \text{ lb/sq in}} = 86.25 \text{ sq in or}$$

$$21.56 \text{ sq in per tire}$$

RATIO AND PROPORTION  
Level 1

Auto Mechanics

Complete Solutions to B Problems (continued)

12.  $\frac{512^{\cancel{X}}}{627^{\cancel{X}}} = \frac{28 \text{ lb/sq in}}{P}$   $P = \text{tire pressure}$

$$512P = 17,556 \text{ lbs/sq in}$$

$$P = 34.29 \text{ lbs/sq in}$$

13.  $D = \text{tire drag}$

$$\frac{21 \frac{3}{4} \cancel{\text{in}}}{\frac{3}{16} \cancel{\text{in}}} = \frac{5280 \text{ ft}}{D}$$

$$21.75D = 990 \text{ ft}$$

$$D = 45.52 \text{ ft}$$

14.  $F = \text{rpm in first gear}$

$$S = \text{rpm in second gear}$$

$$\frac{2.27}{1} = \frac{1,500 \text{ rpm}}{F}$$

$$F = 660.79 \text{ rpm}$$

$$\frac{1.43}{1} = \frac{1,500 \text{ rpm}}{S}$$

$$S = 1,048.95 \text{ rpm}$$

$$S - F = 1,048.95 \text{ rpm} - 660.79 \text{ rpm} = 388.16 \text{ rpm more in second gear than in first gear}$$

15.  $P = \text{force needed to release pressure plate}$

$$45.5 = \frac{980 \text{ lbs}}{P}$$

$$P = 21.54 \text{ lbs}$$

RATIO AND PROPORTION  
Level 1

Auto Mechanics

Complete Solutions to B Problems (continued)

16. T = tension

$$T = \frac{980 \text{ lbs}}{\left(\frac{7 \text{ in}}{3 \text{ in}}\right)\left(\frac{3 \text{ in}}{1 \text{ in}}\right)} = \frac{980 \text{ lbs}}{7} = 140 \text{ lbs}$$

17. S = force produced by overcenter spring

$$(11 \text{ in})(37 \text{ lbs}) = (2 \text{ in})S + (13 \text{ lbs})(11 \text{ in})$$

$$407 \text{ in lbs} = (2 \text{ in})S + 143 \text{ in lbs}$$

$$(2 \text{ in})S = 264 \text{ in lbs}$$

$$S = \frac{264 \text{ in lbs}}{2 \text{ in}}$$

$$S = 132 \text{ lbs}$$

18.  $13 = \frac{x}{20 \text{ lbs}}$      $x = 260 \text{ lbs}$

F = force on the lining

SF = stopping force of the brake

$$\begin{aligned} F &= \frac{(260 \text{ lbs})(2 \text{ } 15/16 \text{ in})^2}{(1 \text{ } 1/8 \text{ in})^2} = \frac{(260 \text{ lbs})(8.6289 \text{ sq in})}{1.2656 \text{ sq in}} \\ &= \frac{2,243.514 \text{ lbs}}{1.2656} \\ &= 1,772.68 \text{ lbs} \end{aligned}$$

$$(0.6)SF = 1,772.68 \text{ lbs}$$

$$SF = 2,954.47 \text{ lbs}$$

19.  $3/4" = 0.75"$      $7/16" = 0.4375"$      $3/8" = 0.375"$   
C = cam lobe lift

$$\frac{0.75 \text{ in}}{1.375 \text{ in}} = \frac{C}{0.4375" + 0.019"}$$

$$1.375C = 0.342375 \text{ in}$$

$$C = 0.249 \text{ in}$$



RATIO AND PROPORTION  
Level 1

Auto Mechanics

Complete Solutions to B Problems (continued)

20. Leverage advantage =  $\left(\frac{13 \text{ in}}{2 \text{ in}}\right)\left(\frac{7 \text{ in}}{3 \text{ in}}\right)\left(\frac{3 \text{ in}}{1 \text{ in}}\right)$   
 $= \frac{273}{6} = 45.5 : 1$

21.  $x$  = pressure in cylinder

$$\frac{640^\circ}{200 \text{ lbs/sq in}} = \frac{1720^\circ}{x}$$

$$(640^\circ)x = 344,000^\circ \text{ lbs/sq in}$$

$$x = \frac{344,000^\circ \text{ lbs/sq in}}{640^\circ}$$

$$x = 537.5 \text{ lbs/sq in}$$

$$\text{Effective pressure} = 537.5 \text{ PSI} - 200 \text{ PSI}$$

$$= 337.5 \text{ PSI}$$

$$\begin{aligned} \text{Force} &= (\text{bore})^2 (0.7854) (\text{PSI}) \\ &= (3.25 \text{ in})^2 (0.7854) (337.5 \text{ lbs/sq in}) \\ &= (10.5625 \text{ sq in}) (0.7854) (337.5 \text{ lbs/sq in}) \\ &= 2799.83 \text{ lbs} \end{aligned}$$

22.  $A$  = rpm alternator pulley  
 $F$  = rpm fan pulley

$$\frac{6 \frac{1}{8} \text{ in}}{2 \frac{1}{4} \text{ in}} = \frac{A}{2,700 \text{ rpm}}$$

$$(2.25)A = 16,537.5 \text{ rpm}$$

$$A = 7,350 \text{ rpm}$$

$$\frac{6 \frac{1}{8} \text{ in}}{7 \frac{3}{4} \text{ in}} = \frac{F}{2,700 \text{ rpm}}$$

$$(7.75)F = 16,537.5 \text{ rpm}$$

$$F = 2,133.87 \text{ rpm}$$

RATIO AND PROPORTION  
Level 1

Diesel Mechanic

A. Problems with Solutions

1. A 12 teeth gear is on a motor shaft. It drives a larger gear having 32 teeth. What is the ratio of the rpm of the motor shaft to the rpm of the larger gear shaft?

Solution:

Since the smaller gear will turn more rpm than the larger, then the ratio is

$$\frac{32 \text{ rpm}}{12 \text{ rpm}} \text{ or } \frac{8 \text{ rpm}}{3 \text{ rpm}}$$

2. A fuel pump delivers 25 ml of fuel in 400 strokes. How many strokes are required to get 40 ml of fuel?

Solution:

$$\frac{25 \text{ ml}}{40 \text{ ml}} = \frac{400 \text{ str}}{x}$$

$$x = \frac{(400 \text{ str})(40 \text{ ml})}{(25 \text{ ml})}$$

$$x = 640 \text{ strokes}$$

3. If the alternator-to engine drive ratio is 2.25:1, what rpm will the alternator have when the engine idle is 500 rpm?

Solution:

$$\frac{2.25}{1} = \frac{x}{500 \text{ rpm}} \quad \text{and } x = 1,125 \text{ rpm}$$

4. A bearing bronze mix is composed of 78% copper, 14% lead, and 8% tin. If 12 lb of copper is used, what is the weight of bearing bronze?

Solution:

$$\frac{12 \text{ lb}}{x} = \frac{78 \text{ lb}}{100 \text{ lb}}$$

$$78 \text{ lb } x = (12 \text{ lb})(100 \text{ lb})$$

$$x = \frac{(12 \text{ lb})(100 \text{ lb})}{78 \text{ lb}}$$

$$x = 15.38 \text{ lb (nearest hundredth)}$$

A. Problems with Solutions (continued)

5. If belted pulleys have diameters of 20 inch and 16 inch, and if the 20 inch turns at 2,000 rpm, how fast will the smaller pulley turn?

Solution:

Their rpms' ratio (larger to smaller) is 16:20 or 4:5. The relation between rpm and diameter is inverse, so,

$$\frac{4}{5} = \frac{2,000 \text{ rpm}}{x} \quad \text{where } x \text{ is the rpm of 16" pulley}$$

$$x = 2,500 \text{ rpm}$$

6. A diesel engine is turned through one revolution. It is connected to a transmission with gear ratio 1.8:1 and then to a differential with gear ratio 5.3:1. How many revolutions will the axle shaft make?

Solution:

Let  $x$  represent the number of turns of the transmission.

$$\frac{1 \text{ rev}}{x} = \frac{1.8}{1} \quad \text{so, } x = \frac{1}{1.8} \text{ rev}$$

Let  $y$  represent the number of turns of the differential.

$$\frac{x \text{ rev}}{y} = \frac{5.3}{1} \quad \text{or } \frac{1/1.8 \text{ rev}}{y} = \frac{5.3}{1} \quad \text{so, } y = \frac{1 \text{ rev}}{(1.8)(5.3)}$$

$$0.105 \text{ rev}$$

B. Problems without Solutions

7. If the combustion chamber volume at bottom dead center (BDC) is 699 cubic inches and the combustion chamber volume at top dead center (TDC) is 49.94 cubic inches, what is the compression ratio?

## Diesel Mechanic

8. If 4 clicks on the adjustment screw changes the valve (inlet) by 0.008 inches, how many clicks are needed for an adjustment of 0.020 inches?

9. A diesel truck was driven 228 miles on 38 gallons of diesel fuel. How much fuel would be required to drive 558 miles?
10. A shaft that has a taper of 0.125 inches in 4 inches, would have a taper of how much over its entire length if it was 12 feet long?
11. If the horsepower developed by an engine varies directly as its displacement, how many horsepower will be developed by an engine with a displacement of 225 cu in if a 390 cu in develops 225 hp.

B. Problems without Solutions (continued)

12. If 40 gallons of oil flow through a feeder pipe in 20 minutes, how long will it take to full a tank of 650-gallon capacity?
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
13. A cylindrical tank holds 500 gallons when it is filled to its full height of 7 ft. When the gauge shows that it contains oil at a height of 2 ft 6 in, how many gallons are in the tank?
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
14. Suppose the pressure in a storage tank varies directly with depth. If the pressure is 4.35 lb/sq in at a depth of 10 ft, what is the pressure at the bottom of a 35-ft tank if the tank is completely filled?
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
15. The driving gear has 12 teeth and has a diameter of 3 in. What will the diameter of the driven gear be if it has 16 teeth?



B. Problems without Solutions (continued)

16. A bearing bronze mix is composed of 78% copper, 14% lead and 8% tin. What weight of bearing bronze could be made if 6 lb of lead are used?
17. The tin used in melting of bearing bronze weighs  $8 \frac{3}{4}$  lbs. How much does the total bearing bronze weigh? (Use information from problem 16.)
18. In order to drive a piece of equipment at a satisfactory rate, it is necessary to secure a final shaft speed of 1,200 rpm. The engine's drive shaft is turning at 1,800 rpm and has a drive gear with 64 teeth. In order to secure the desired final shaft speed, the 64-tooth gear must turn the final drive through a gear having how many teeth?

B. Problems without Solutions (continued)

19. Compute the missing values in the table relating the number of teeth in a gear and its RPM.

| <u>No of Teeth<br/>in Driver Gear</u> | <u>No of Teeth<br/>in Driven Gear</u> | <u>RPM of<br/>Driver Gear</u> | <u>RPM of<br/>Driven Gear</u> |
|---------------------------------------|---------------------------------------|-------------------------------|-------------------------------|
| 15                                    | A =                                   | 400                           | 150                           |
| B =                                   | 120                                   | 40                            | 16                            |
| 30                                    | 80                                    | C =                           | 600                           |
| 16                                    | 90                                    | 72                            | D =                           |

20. Determine the duration of fuel injection in seconds for an engine running at 1,400 rpm, if the start of injection occurs at  $15.5^{\circ}$  b.t.c. and the end of injection at  $5.5^{\circ}$  a.t.c.

RATIO AND PROPORTION  
Level 1

Diesel Mechanic

Complete Solutions to B Problems

7.  $\frac{699 \text{ cu in}}{49.94 \text{ cu in}} \approx 14$ , so ratio is  $\frac{14}{1}$

8.  $\frac{4}{x} = \frac{0.008"}{0.020"}$

$8"x = (4 \text{ clicks})(20")$

$x = 10 \text{ clicks}$ , or 1 click is equal to 0.002 in, so, 10 clicks are needed for 0.020 in

9.  $\frac{38 \text{ gal}}{x} = \frac{228 \text{ mf}}{558 \text{ mf}}$

$x = 93 \text{ gal}$

10. Since 12 feet = 144 inches,

$\frac{0.125 \text{ in}}{x} = \frac{4 \text{ in}}{144 \text{ in}}$

$(4 \text{ in})x = 18 \text{ sq in}$

$x = 4.50 \text{ inches}$

11.  $\frac{225 \text{ cu in}}{390 \text{ cu in}} = \frac{x}{255 \text{ hp}}$

$x = \frac{(225 \text{ hp})(255 \text{ cu in})}{390 \text{ cu in}}$

$147.1 \text{ hp (to the nearest tenth)}$

12.  $\frac{40 \text{ gal}}{650 \text{ gal}} = \frac{20 \text{ min}}{x} \text{ or } \frac{650 \text{ gal}}{40 \text{ gal}} = \frac{x}{20 \text{ min}}$

$x = \frac{(20 \text{ min})(650 \text{ gal})}{40 \text{ gal}}$

$= 325 \text{ minutes or } 5 \text{ hours, } 25 \text{ minutes}$

RATIO AND PROPORTION  
Level 1

Diesel Mechanic

Complete Solutions to B Problems (continued)

13.  $\frac{2.5 \text{ ft}}{7 \text{ ft}} = \frac{x}{500 \text{ gal}}$

$$\frac{1,250 \text{ gal-ft}}{7 \text{ ft}} = x$$

$$x = 178.57 \text{ gallons}$$

14.  $\frac{4.35 \text{ lb/sq in}}{x} = \frac{10 \text{ ft}}{35 \text{ ft}}$

$$x = \frac{(35 \text{ ft})(4.35 \text{ lb/sq in})}{10 \text{ ft}}$$

$$x = 15.225 \text{ lbs/sq in}$$

15.  $\frac{x}{3 \text{ in}} = \frac{16 \text{ teeth}}{12 \text{ teeth}}$

$$x = 4 \text{ inches}$$

Level 2

16.  $\frac{6 \text{ lb}}{x} = \frac{14 \text{ lb}}{100 \text{ lb}}$

$$x = 42.86 \text{ lb (to nearest hundredth)}$$

17.  $\frac{8 \frac{3}{4} \text{ lb}}{x} = \frac{8\%}{100\%}$

$$x = 109.38 \text{ lb (to nearest hundredth)}$$

18.  $\frac{1,200 \text{ rpm}}{1,800 \text{ rpm}} = \frac{64 \text{ teeth}}{x}$

$$1,200 \text{ rpm } x = 115,200 \text{ rpm/teeth}$$

$$x = 96 \text{ teeth}$$

RATIO AND PROPORTION  
Level 2

Diesel Mechanic

Complete Solutions to B Problems (continued)

19. Since the number of teeth and its RPM are inversely proportional, the proportion for the first problem is  $\frac{x}{15 \text{ teeth}} = \frac{400 \text{ rpm}}{150 \text{ rpm}}$ , so

$$x = 40 \text{ teeth}$$

The solution of similar proportions for the rest of the data will yield the remaining answers.

A = 40 teeth, B = 48 teeth, C = 1,600 teeth and D = 12.8 teeth

20. At 1,400 rpm, there would be a turning of (1,400 revolutions) x (360 degrees/revolution) or 504,000 degrees per minute or 8,400 degrees per second. Therefore,

$$\frac{15.5^\circ + 5.5^\circ}{8400^\circ} = \frac{x}{1 \text{ sec}}$$

$$x = 0.0025 \text{ seconds}$$



RATIO AND PROPORTION  
Level 1

Industrial Mechanics

A. Problems with Solutions

1. A gear with 72 teeth meshes with a gear with 24 teeth. The larger gear has a speed of 180 rpms. What is the rpms of the smaller gear?

Solution:

$x$  = rpms of smaller gear

$$\frac{x}{180 \text{ rpms}} = \frac{72 \text{ teeth}}{24 \text{ teeth}}$$

$$24x = (180 \text{ rpms})(72)$$

$$24x = 12,960 \text{ rpms}$$

$$x = \frac{12,960 \text{ rpms}}{24}$$

$$x = 540 \text{ rpms}$$

2. If 50 gallons of oil flowed through a feeder pipe in 20 minutes, how long will it take to fill a tank of 1,250 gallon capacity?

Solution:

$t$  = time to fill tank

$$\frac{t}{20 \text{ min}} = \frac{1,250 \text{ gal}}{50 \text{ gal}}$$

$$50t = (20 \text{ min})(1,250)$$

$$50t = 25,000 \text{ min}$$

$$t = \frac{25,000 \text{ min}}{50}$$

$$t = 500 \text{ min or } 8 \text{ hrs } 20 \text{ min}$$

A. Problems with Solutions (continued)

3. If 3/8" cable will support a load of 2,000 lbs, how much would the same kind of cable 9/16" in diameter support?

Solution:

The load a wire supports is proportional to its cross-sectional area.

w = weight supported by 9/16" cable

$$\frac{w}{2,000 \text{ lbs}} = \frac{\pi(9/16 \text{ in})^2}{\pi(3/8 \text{ in})^2}$$

$$\frac{w}{2,000 \text{ lbs}} = \frac{81/256 \text{ sq in}}{9/64 \text{ sq in}}$$

$$(9/64)w = (81/256)(2,000 \text{ lbs})$$

$$w = \frac{(64)(81)(2,000 \text{ lbs})}{(9)(256)}$$

$$w = 4,500 \text{ lbs}$$

B. Problems without Solutions

4. A 15.3" piece of shaft has a taper of 0.065". What is the taper in a 4" piece of the same shafting?
5. The pressure of water increases with the depth. If the pressure is 6.72 lbs per square inch at a depth of 15', what is the pressure at a depth of 25'8"?

## Industrial Mechanics

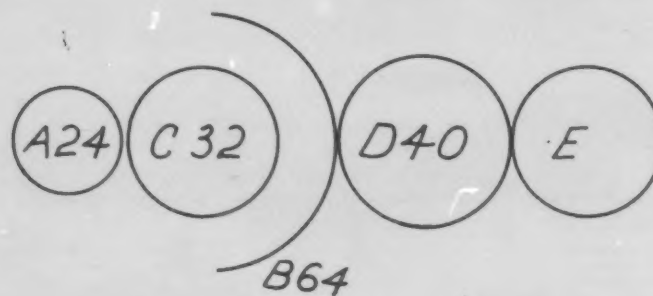
6. Seventeen taps cost \$10.50, what would 7 taps cost?

7. For each  $2.5^{\circ}\text{C}$  increase in water temperature above  $20.0^{\circ}\text{C}$ , a certain thermostatically controlled valve opens  $0.035"$ . Find the valve opening at
- (a)  $62^{\circ}\text{C}$
  - (b)  $98^{\circ}\text{C}$
  - (c) What is the water temperature when the valve opening is  $0.84"$ ?
8. Of two gears in mesh, one turns at a rate of 75 rpms, and the other turns at 50 rpms. What is their gear ratio?

B. Problems without Solutions (continued)

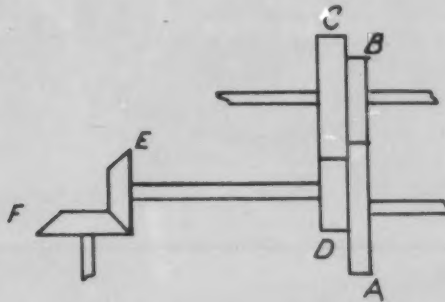
9. A step pulley has steps of 3", 3 1/2" and 4" in diameter, and running at 3400 rpms drives another step pulley with steps of 3", 3 1/2" and 4". What speeds can be obtained?

10. Gear E in the figure is required to make 100 rpms while A makes 75 rpms. How many teeth must E have if A has 24; B has 64; C has 32; and D has 40 teeth? (Gears C and B are on the same shaft)



B. Problems without Solutions (continued)

11. In the figure how many teeth must F have if it is required to make 320 rpms while A makes 120 rpms and has 72 teeth; B has 24 teeth; C has 40 teeth; D has 36 teeth; and E has 32 teeth? (Gears B and C are on the same shaft. Gear D and E are on the same shaft.)





RATIO AND PROPORTION  
Level 1

Industrial Mechanics

Complete Solutions to B Problems

4.  $t = \text{taper in } 4''$

$$\frac{t}{0.065''} = \frac{4 \text{ in}}{15.3 \text{ in}}$$

$$15.3t = 4(0.065'')$$

$$15.3t = 0.26''$$

$$t = \frac{0.26''}{15.3}$$

$$t = 0.017 \text{ in}$$

5.  $p = \text{pressure at } 25' 8'' \text{ or } 25.67'$

$$\frac{p}{6.72 \text{ lbs/sq in}} = \frac{25.67 \text{ ft}}{15 \text{ ft}}$$

$$15p = (6.72 \text{ lbs/sq in})(25.67)$$

$$15p = 172.5 \text{ lbs/sq in}$$

$$p = \frac{172.5 \text{ lbs/sq in}}{15}$$

$$p = 11.5 \text{ lbs/sq in}$$

6.  $c = \text{cost of } 7 \text{ taps}$

$$\frac{c}{\$10.50} = \frac{7 \text{ taps}}{17 \text{ taps}}$$

$$17c = 7(\$10.50)$$

$$17c = \$73.50$$

$$c = \frac{\$73.50}{17}$$

$$c = \$4.32$$

Complete Solutions to B Problems (continued)

7.  $x$  = valve opening

(a) at  $62^{\circ}\text{C}$  valve is affected by  $62^{\circ}\text{C} - 20.0^{\circ}\text{C} = 42^{\circ}\text{C}$

$$\frac{x}{0.035"} = \frac{42^{\circ}\text{C}}{2.5^{\circ}\text{C}} \quad 2.5x = 42(0.035")$$

$$2.5x = 1.47"$$

$$x = 0.588 \text{ in}$$

(b) at  $98^{\circ}\text{C}$  valve is affected by  $98^{\circ}\text{C} - 20.0^{\circ}\text{C} = 78^{\circ}\text{C}$

$$\frac{x}{0.035"} = \frac{78^{\circ}\text{C}}{2.5^{\circ}\text{C}} \quad 2.5x = 78(0.035")$$

$$2.5x = 2.730"$$

$$x = 1.092 \text{ in}$$

(c)  $t$  = temperature producing opening of  $0.84"$

$$\frac{t}{2.5^{\circ}\text{C}} = \frac{0.84 \text{ in}}{0.035 \text{ in}} \quad 0.035t = (0.84)(2.5^{\circ}\text{C})$$

$$0.035t = 2.1^{\circ}\text{C}$$

$$t = 60^{\circ}\text{C}$$

true temperature is  $t + 20^{\circ}\text{C} = 80^{\circ}\text{C}$

8. either  $75:50 = 3:2$

or  $50:75 = 2:3$

9. Possible combinations are:

$r$  = rpms of driven pulley

$$3:3 \quad \frac{r}{3,400 \text{ rpms}} = \frac{3 \text{ in}}{3 \text{ in}}$$

$$3:3 \text{ } 1/2 \quad \frac{r}{3,400 \text{ rpms}} = \frac{3 \text{ in}}{3 \text{ } 1/2 \text{ in}}$$

$$\frac{r}{3,400 \text{ rpms}} = 1$$

$$(3 \text{ } 1/2)r = 10,200 \text{ rpms}$$

$$r = 2,914 \text{ rpms}$$

$$r = 3,400 \text{ rpms}$$

Complete Solutions to B Problems (continued)

9. (continued)

$$3:4 \quad \frac{r}{3,400 \text{ rpms}} = \frac{3 \cancel{4}q}{4 \cancel{4}q}$$

$$4r = 10,200 \text{ rpms}$$

$$r = 2,550 \text{ rpms}$$

$$3 \frac{1}{2}:3 \quad \frac{r}{3,400 \text{ rpms}} = \frac{3 \frac{1}{2} \cancel{4}q}{3 \cancel{4}q}$$

$$3r = 11,900 \text{ rpms}$$

$$r = 3,967 \text{ rpms}$$

$$3 \frac{1}{2}:3 \frac{1}{2} \quad \frac{r}{3,400 \text{ rpms}} = \frac{3 \frac{1}{2} \cancel{4}q}{3 \frac{1}{2} \cancel{4}q}$$

$$r = 3,400 \text{ rpms}$$

$$3 \frac{1}{2}:4 \quad \frac{r}{3,400 \text{ rpms}} = \frac{3 \frac{1}{2} \cancel{4}q}{4 \cancel{4}q}$$

$$4r = 11,900 \text{ rpms}$$

$$r = 2,975 \text{ rpms}$$

$$4:3 \quad \frac{r}{3,400 \text{ rpms}} = \frac{4 \cancel{4}q}{3 \cancel{4}q}$$

$$3r = 13,600 \text{ rpms}$$

$$r = 4,533 \text{ rpms}$$

$$4:3 \frac{1}{2} \quad \frac{r}{3,400 \text{ rpms}} = \frac{4 \cancel{4}q}{3 \frac{1}{2} \cancel{4}q}$$

$$(3 \frac{1}{2})r = 13,600 \text{ rpms}$$

$$r = 3,886 \text{ rpms}$$

$$4:4 \quad \frac{r}{3,400 \text{ rpms}} = \frac{4 \cancel{4}q}{4 \cancel{4}q}$$

$$r = 3,400 \text{ rpms}$$

10. Compute the rpms of each gear in succession

$$\text{rpm of C} : \frac{24 \text{ teeth}}{32 \text{ teeth}} = \frac{C}{75 \text{ rpm}} \quad 32C = 1,800 \text{ rpm}$$

$$C = 56.25 \text{ rpm}$$

rpm of B = rpm of C since they are on the same shaft

$$B = 56.25 \text{ rpm}$$

$$\text{rpm of D} : \frac{64 \text{ teeth}}{40 \text{ teeth}} = \frac{D}{56.25 \text{ rpm}} \quad 40D = 3,600 \text{ rpm}$$

$$D = 90 \text{ rpm}$$

$$\text{rpm of E} = 100 \text{ rpm} \quad t = \text{teeth in E}$$

$$\frac{t}{40 \text{ teeth}} = \frac{90 \text{ rpm}}{100 \text{ rpm}} \quad 100t = 3600 \text{ teeth}$$

$$t = 36 \text{ teeth}$$

Complete Solutions to B Problems (continued)

11. Compute the rpm of each gear in succession

$$\text{rpm of B : } \frac{B}{120 \text{ rpm}} = \frac{72 \text{ teeth}}{24 \text{ teeth}} \quad 24B = 8,640 \text{ rpm}$$

$$B = 360 \text{ rpm}$$

rpm of C = rpm of B since they are on the same shaft

$$\text{rpm of C} = 360 \text{ rpm}$$

$$\text{rpm of D : } \frac{D}{360 \text{ rpm}} = \frac{40 \text{ teeth}}{36 \text{ teeth}} \quad 36D = 14,400 \text{ rpm}$$

$$D = 400 \text{ rpm}$$

rpm of E = rpm of D since they are on the same shaft

$$\text{rpm of E} = 400 \text{ rpm}$$

t = teeth in F

$$\frac{t}{32 \text{ teeth}} = \frac{400 \text{ rpm}}{320 \text{ rpm}} \quad 320t = 12,800 \text{ teeth} \quad t = 40 \text{ teeth}$$

RATIO AND PROPORTION  
Level 1

Aviation Mechanics

A. Problems with Solutions

1. A quantity of gas has a volume of 10 cu ft at 10° Centigrade. Find the volume at 100° C.

Solution:

Must convert temperature indications to absolute (Kelvin) values. This can be done by adding 273 to the Centigrade value. Then 10° C becomes 283° K and 100° C becomes 373° K. Applying Charles' Law,

$$\frac{V_1}{V_2} = \frac{T_1}{T_2} \quad , \quad \frac{10}{V_2} = \frac{283}{373} \quad ; \quad V_2 = 13.18 \text{ cu ft}$$

B. Problems without Solutions

2. Compute the compression ratio of an engine which has a bore of 5 inches when the volume of the combustion chamber is 16.36 cu in with the piston at top dead center.
3. What mechanical advantage can be obtained when a drive gear has 30 teeth and a driven gear has 120 teeth?
4. If the volume of space in a cylinder is 120 cu in when the piston is at the bottom of its stroke, and the volume is 20 cu in when the piston is at the top of its stroke, what is the compression ratio?



RATIO AND PROPORTION  
Level 1

Aviation Mechanics

Complete Solutions to B Problems

2.  $(16.36 + 1/4(3.14) 5^3) : 16.36$

$114.48 : 16.36$

Approximately  $114 \frac{1}{2} : 16 \frac{1}{3}$

$687 : 98$

Almost 7 to 1

3.  $120 : 30$  or  $4 : 1$

4.  $120 : 20$  ,  $120/20$  ,  $6/1$  , or  $6 : 1$

RATIO & PROPORTION  
Level I

Nursing

A. Problems with solutions.

1. Solve for x :  $420 : 600 = x : 50$

Solution:  $\frac{420}{600} = \frac{x}{50}$

$$(600)(x) = (50)(420)$$

$$x = \frac{(50)(420)}{600}$$

$$x = 35$$

2. Solve for x :  $1/2 : 3/4 = x : 5/6$

$$\frac{1/2}{3/4} = \frac{x}{5/6}$$

$$(5/6)(1/2) = (3/4)(x)$$

$$\frac{(5/6)(1/2)}{3/4} = x$$

$$\frac{5/12}{3/4} = x$$

$$(5/12)(4/3) = x$$

$$20/36 = x$$

$$5/9 = x$$

3. Solve for x:

$$.004:1 = .07:x$$

$$\frac{0.004}{1} = \frac{0.07}{x}$$

$$(0.004)(x) = (0.07)(1)$$

$$x = \frac{(0.07)(1)}{0.004}$$

$$x = 17.50$$

RATIO & PROPORTION  
Level I

Nursing

B. Problems without solutions.

4. Solve for X :

$$x:20 = 4:10$$

5. a)  $15:x = 6:10$

b)  $5/9:x = 5:6$

c)  $1/2:10 = 1:x$

d)  $2/3:3/4 = 4:x$

e)  $.004:1 = .07:x$

6. a)  $x:6 = 10:12$

b)  $5:9 = x:36$

c)  $2:8 = x:3$

d)  $x:20 = 4:10$

e)  $3:x = 6:9$

RATIO AND PROPORTION  
Level I

Nursing

B. Problems without solutions.

7. a)  $4 : 6 =$  \_\_\_\_\_  
b)  $5 : 100$  \_\_\_\_\_  
c)  $35:14$  \_\_\_\_\_

Express in fraction, reduced to the lowest terms.

8. The label reads: 5 cc of solutions contains gr X of Potassium Chloride. How many cc's would be needed to give gr XV?

9. You are to administer 40 mg of Aminophylline from a bottle marked 250 mg/10 cc. How many cc's shall be drawn (nearest tenth)?

10. The multiple-dose vial has been mixed and labeled: 400,000 units in 1cc. How many cc would be needed to give 600,000 units?

11. The label on the 1 cc vial reads: Dilaudid gr  $1/32$ . How many vials would you use to give Dilaudid gr  $1/64$ ?

RATIO AND PROPORTION  
Level I

Nursing

B. Problems without solutions.

12. A label reads: 4 cc of solution contains gr V of Potassium Chloride.  
How many cc would be needed to give gr XV?
  
  
  
  
  
  
  
  
  
  
13. A label reads: Gantrisin 0.5 gm in 5 cc. How much liquid Gantrisin  
would be needed to give 1.0 gm?
  
  
  
  
  
  
  
  
  
  
14. The multiple-dose vial has been mixed and labeled: 200,000 Units in  
1 cc. How many cc's would be needed to give 500,00 Units?
  
  
  
  
  
  
  
  
  
  
15. If 4 cc of solution contains gr V of a drug, how much would be needed  
to give gr XV?
  
  
  
  
  
  
  
  
  
  
16. The label reads: Sodium Salicylate gr V. In order to give gr XX,  
use \_\_\_\_\_ tabs.



RATIO AND PROPORTION  
Level I

Nursing

B. Problems without solutions.

17. The label reads: Thyroid gr ss. How many tablets would be needed to give gr IIss? \_\_\_\_\_ tabs
18. 1000 cc's of a solution is ordered over a period of 12 hours to be given intraveineously. How many drops per minute is this?
19. 1000 cc's of a solution is ordered for intravenous administration over a period of 10 hours. How many cc's is this per minute?
20. 1000 cc's of a solution is ordered intraveineously over a period of 6 hours. How many cc's per minute is this?
21. 1000 cc's of a solution is ordered over a period of 8 hours. How many minims is this per minute?
22. The dose of Elixir of Terpin Hydrate is 4 cc. How many doses would there be in 1 pint?

RATIO AND PROPORTION  
Level I

Nursing

Problems without solutions.

23. The label on an ampule of Lasix reads 10 mg/cc. The ampule has a 2 cc total volume. How many ampules need to be used for a medication request of 40 mg? How many cc's would that be (to the nearest tenth)?
24. Give 1.25 mg of Reserpine. It comes in 2 cc vials marked 1cc/5mg. How many cc's would you need (to the nearest hundredth)?
25. A bottle of medication has indicated on the label 1.5 gm/3ml. How many ml would you need to be equivalent to 400 mg. (nearest tenth)?
26. A patient is to receive 1200 cc of an IV solution over a period of 8 hours. How many minims is this per minute (nearest whole minim)?
27. An order is for 1.3 gms of Keflin. Keflin comes 1 gm in 4 cc. How many cc's would you give?

RATIO AND PROPORTION  
Level I

Nursing

B. Problems without solutions.

28. 0.15 mg = \_\_\_\_\_ tablets if 1 tablet = 0.3 mg.

29. 0.6 mg = \_\_\_\_\_ tablets if 1 tablet = 0.12 mg.

30. Tablet size is 400 mg/tablet. An order of 200 mg = \_\_\_\_\_ tablet.

31. Tablet size 0.25 mg/tablet. An order of 0.125 mg = \_\_\_\_\_ tablet.

32. A medication is to consist of 35 mg of Demerol. The vial is marked 50 mg/cc in a 30 cc vial. How many cc's shall be drawn (nearest tenth)?

B. Problems without solutions.

33. 400 mg of Konamycin is to be given from a vial labeled 1 gm/3 cc.  
How many cc's need to be drawn (nearest tenth)?
34. The tag on a vial of hydrocortasine reads 50mg/cc. How many cc's  
need to be drawn in order to give a medication of 140 mg (nearest  
tenth)?
35. A required medication of 60 mg. of phenobarbital needs to be administered.  
The ampule reads 130 mg (2 gr) = 1cc. How many cc's should be drawn  
(nearest tenth)? How many grams (nearest eighths)?
36. What ratio is 5 cents to \$1.00?
37. 1 : 20 is what percent?
38. What percent of 20 is 5?
39. 10% of what number is 90?

RATIO AND PROPORTION  
Level I

Nursing

Complete solutions to B problems.

$$4. \frac{x}{20} = \frac{4}{10}$$

$$\begin{aligned} (10)(x) &= (20)(4) \\ x &= \frac{(20)(4)}{10} \\ x &= 8 \end{aligned}$$

5. In both 5 and 6 (below), use the means-extremes product property of equality. This says the product of the means equals the product of the extremes.. Then divide to find the desired unknown.

$$a) \frac{15}{x} = \frac{6}{10}$$

$$150 = 6x$$

$$\frac{150}{6} = x$$

$$25 = x$$

$$b) \frac{5/9}{x} = \frac{5}{6}$$

$$(5/9)(6) = 5x$$

$$\frac{(5/9)(6)}{5} = x$$

$$2/3 = x$$

$$c) \frac{1/2}{10} = \frac{1}{x}$$

$$1/2x = 10$$

$$x = \frac{10}{1/2}$$

$$x = 20$$

$$d) \frac{2/3}{3/4} = \frac{4}{x}$$

$$2/3 x = 3$$

$$x = \frac{3}{2/3}$$

$$x = 9/2 = 4 \frac{1}{2}$$

$$e) \frac{0.004}{1} = \frac{0.07}{x}$$

$$0.004 x = 0.07$$

$$x = \frac{0.07}{0.004}$$

$$x = 17.5$$

$$6. a) \frac{x}{6} = \frac{10}{12}$$

$$12x = 60$$

$$x = \frac{60}{12}$$

$$x = 10$$

$$b) \frac{5}{9} = \frac{x}{36}$$

$$9x = 180$$

$$x = \frac{180}{9}$$

$$x = 20$$

$$c) \frac{2}{8} = \frac{x}{3}$$

$$8x = 6$$

$$x = 6/8$$

$$x = 3/4$$

$$d) \frac{x}{20} = \frac{4}{10}$$

$$10x = 80$$

$$x = 80/10$$

$$x = 8$$

$$e) \frac{3}{x} = \frac{6}{9}$$

$$6x = 27$$

$$x = \frac{27}{6}$$

$$x = 9/2 = 4 \frac{1}{2}$$



RATIO AND PROPORTION  
Level I

Nursing

Complete solutions to B problems.

7. a)  $4/6 = 2/3$

b)  $5/100 = 1/20$

c)  $35/14 = 5/2$

8.  $\frac{10 \text{ gr}}{5 \text{ cc}} = \frac{15 \text{ gr}}{N}$

$$(10 \text{ gr})(N) = (15 \text{ gr})(5 \text{ cc})$$

$$N = \frac{(15 \text{ gr})(5 \text{ cc})}{10 \text{ gr}}$$

$$N = 7.5 \text{ cc}$$

9.  $\frac{250 \text{ mg}}{10 \text{ cc}} = \frac{40 \text{ mg}}{N}$

$$(250 \text{ mg})(N) = (40 \text{ mg})(10 \text{ cc})$$

$$N = \frac{(40 \text{ mg})(10 \text{ cc})}{250 \text{ mg}}$$

$$N = 1.6 \text{ cc}$$

10.  $\frac{400,000 \text{ units}}{1 \text{ cc}} = \frac{600,000 \text{ units}}{N}$

$$(400,000 \text{ units})(N) = (600,000 \text{ units})(1 \text{ cc})$$

$$N = \frac{(600,000 \text{ units})(1 \text{ cc})}{400,000 \text{ units}}$$

$$N = 1.5 \text{ cc}$$

11. By inspection the solutions is 1/2 vial.

$$\frac{1/64 \text{ gr/dose}}{1/32 \text{ gr/vial}} = 1/2 \text{ vial/dose}$$

12.

$$\frac{4 \text{ cc}}{5 \text{ gr}} = \frac{N}{15 \text{ gr}}$$

$$(5 \text{ gr})(N) = (15 \text{ gr})(4 \text{ cc})$$

$$N = \frac{(15 \text{ gr})(4 \text{ cc})}{5 \text{ gr}}$$

$$N = 12 \text{ cc}$$

RATIO AND PROPORTION  
Level I

Nursing

Complete solutions to B problems.

$$13. \frac{0.5 \text{ gm}}{5 \text{ cc}} = \frac{1.0 \text{ gm}}{N}$$

$$(0.5 \text{ gm})(N) = (1.0 \text{ gm})(5 \text{ cc})$$

$$N = \frac{(1.0 \text{ gm})(5 \text{ cc})}{0.5 \text{ gm}}$$

$$N = 10 \text{ cc}$$

$$14. \frac{200,000 \text{ units}}{1 \text{ cc}} = \frac{500,000 \text{ units}}{N}$$

$$(200,000 \text{ units})(N) = (500,000 \text{ units})(1 \text{ cc})$$

$$N = \frac{(500,000 \text{ units})(1 \text{ cc})}{200,000 \text{ units}}$$

$$N = 2.50 \text{ cc}$$

$$15. \frac{4 \text{ cc}}{5 \text{ gr}} = \frac{N}{15 \text{ gr}}$$

$$(5 \text{ gr})(N) = (4 \text{ cc})(15 \text{ gr})$$

$$N = \frac{(4 \text{ cc})(15 \text{ gr})}{5 \text{ gr}}$$

$$N = 12 \text{ cc}$$

$$16. \frac{20 \text{ gms}}{5 \text{ gm/tablet}} = 4 \text{ tablets}$$

$$17. \frac{2.5 \text{ gms}}{5 \text{ gm/tablet}} = 5 \text{ tablets}$$

$$18. \left( \frac{1000 \text{ cc}}{12 \text{ hrs}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) = (1.4 \text{ cc/min})(60 \text{ drop/cc}) = 84$$

$$19. \left( \frac{1000 \text{ cc}}{10 \text{ hrs}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) = 1.7 \text{ cc/min}$$

$$20. \left( \frac{1000 \text{ cc}}{6 \text{ hrs}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) = 2.8 \text{ cc/min}$$

$$21. \left( \frac{1000 \text{ cc}}{8 \text{ hr}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) \left( \frac{60 \text{ minims}}{1 \text{ cc}} \right) = 125 \text{ minims/min}$$

RATIO AND PROPORTION  
Level I

Nursing

Complete solutions to B problems

22. 500 cc's = 1 pint

$$\frac{500 \text{ cc}}{4 \text{ cc/dose}} = 125 \text{ doses}$$

23.  $\left( \frac{10 \text{ mg}}{\text{cc}} \right) \left( \frac{2 \text{ cc}}{\text{ampule}} \right) = 20 \text{ mg/ampule}$

$$\frac{40 \text{ mg}}{20 \text{ mg/ampule}} = 2 \text{ ampules} = 4 \text{ cc's}$$

24.  $\frac{1 \text{ cc}}{5 \text{ mg}} = \frac{N}{1.25 \text{ mg}}$

$$(5 \text{ mg})(N) = (1 \text{ cc})(1.25 \text{ mg})$$

$$N = \frac{(1 \text{ cc})(1.25 \text{ mg})}{5 \text{ mg}}$$

$$N = 0.25 \text{ cc}$$

25.  $\frac{1.5 \text{ gm}}{3 \text{ ml}} = \frac{0.400 \text{ gm}}{N}$

$$(1.5 \text{ gm})(N) = (0.400 \text{ gm})(3 \text{ ml})$$

$$N = \frac{(0.400 \text{ gm})(3 \text{ ml})}{1.5 \text{ gm}}$$

$$N = .80 \text{ ml}$$

26.  $\left( \frac{1200 \text{ cc}}{8 \text{ hrs}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) \left( \frac{60 \text{ minims}}{1 \text{ cc}} \right) = 150 \text{ minims/min}$

27.  $\frac{1 \text{ gm}}{4 \text{ cc}} = \frac{1.3 \text{ gm}}{N}$

$$(1 \text{ gm})(N) = (1.3 \text{ gm})(4 \text{ cc})$$

$$N = \frac{(1.3 \text{ gm})(4 \text{ cc})}{1 \text{ gm}}$$

$$N = 5.2 \text{ cc}$$

RATIO AND PROPORTION  
Level I

Nursing

Complete solutions to B problems.

$$28. \frac{0.15 \text{ mg}}{0.3 \text{ mg/tablet}} = 0.5 \text{ tablet}$$

$$29. \frac{0.6 \text{ mg}}{0.12 \text{ mg/tablet}} = 5 \text{ tablets}$$

$$30. \frac{200 \text{ mg}}{400 \text{ mg/tablet}} = 0.5 \text{ tablets}$$

$$31. \frac{0.125 \text{ mg}}{.25 \text{ mg/tablet}} = 0.5 \text{ tablets}$$

$$32. \frac{35 \text{ mg}}{N} = \frac{50 \text{ mg}}{1 \text{ cc}}$$

$$(50 \text{ mg})(N) = (35 \text{ mg})(1 \text{ cc})$$

$$N = \frac{(35 \text{ mg})(1 \text{ cc})}{50 \text{ mg}}$$

$$N = 0.7 \text{ cc}$$

$$33. \frac{1 \text{ gm}}{3 \text{ cc}} = \frac{0.400 \text{ gm}}{N}$$

$$(1 \text{ gm})(N) = (0.4 \text{ gm})(3 \text{ cc})$$

$$N = \frac{(0.4 \text{ gm})(3 \text{ cc})}{1 \text{ gm}}$$

$$N = 1.2 \text{ cc}$$

$$34. \frac{140 \text{ mg}}{50 \text{ mg/cc}} = 2.8 \text{ cc}$$

$$35. \frac{60 \text{ mg}}{130 \text{ mg/cc}} = 0.5 \text{ cc}$$

$$36. \frac{0.05}{1.00} = \frac{1}{20}$$

$$37. (1/20)(100) = 5\%$$

$$38. (5/20)(100) = 25\%$$

$$39. (0.10)(N) = 90$$

$$N = 90/0.10$$

$$N = 900$$

RATIO AND PROPORTION  
Level 1

Clerical

A. Problems with Solutions

1. A salesman was paid a commission of \$20 for selling \$250 worth of goods. What should be his commission on \$350 of sales at the same rate of commission?

The ratio of the dollars of commissions equals the ratio of the dollars of sales.

Solution:

$$\frac{\$20}{\$250} = \frac{x}{\$350}$$

$$250x = (\$350)(20)$$

$$250x = \$7,000$$

$$x = \$28$$

2. Aaron Rank sells a customer a 5-yard remnant of Chintz for \$2.75. "Here's another piece of 13 yards," he says, "that you can buy at the same rate." How much is Aaron Rank asking for the 13 yard piece?

Solution:

$$\frac{5 \text{ yards}}{\$2.75} = \frac{13 \text{ yards}}{x}$$

$$(5 \text{ yards})x = \$35.75 \text{ yards}$$

$$x = \frac{\$35.75 \text{ yards}}{5 \text{ yards}}$$

$$x = \$7.15$$

3. Dick was paid \$5.85 for working 4 1/2 hours. At the same rate, how much should he be paid for working 7 hours?

The ratio of the dollars equals the ratio of the hours.

Solution:

$$\frac{4.5 \text{ hr}}{\$5.85} = \frac{7 \text{ hr}}{s}$$

$$(4.5 \text{ hr})s = \$40.95 \times \text{hr}$$

$$s = \frac{\$40.95 \times \cancel{\text{hr}}}{4.5 \cancel{\text{hr}}}$$

$$s = \$9.10$$



RATIO AND PROPORTION  
Level 1

Clerical

A. Problems with Solutions (continued)

4. Blend x is mixed in the following proportions:

Ingredient A 1 part  
Ingredient B 2 parts  
Ingredient C 6 parts

If a batch containing one quart of Ingredient B is mixed, how many pint bottles can be filled?

Solution:

B = 2 pints

$$\frac{1}{2} = \frac{A}{2 \text{ pts}}$$

A = 1 pt

$$\frac{1}{6} = \frac{A}{C}$$

$$\frac{1}{6} = \frac{1 \text{ pt}}{C}$$

C = 6 pts

Total pints = 1 pt + 2 pts + 6 pts = 9 pts

5. Sales expenses for ABC Appliance are distributed along product lines. Total expenses for 1970 were \$17,350. Distribute the expenses in proportion to sales for each product.

| <u>Product</u> | <u>Sales</u>     | <u>Expenses</u> |
|----------------|------------------|-----------------|
| Toasters       | \$36,450         |                 |
| Mixers         | 42,600           |                 |
| Irons          | 35,200           |                 |
| Clock-Radios   | 48,150           |                 |
| Other          | 19,275           |                 |
|                | <u>\$181,675</u> | <u>\$17,350</u> |

Solution:

|              |                                             |                         |
|--------------|---------------------------------------------|-------------------------|
| Toasters     | $\left( \frac{\$36,450}{\$181,675} \right)$ | (\$17,350) = \$3,480.98 |
| Mixers       | $\left( \frac{\$42,600}{\$181,675} \right)$ | (\$17,350) = \$4,068.31 |
| Irons        | $\left( \frac{\$35,200}{\$181,675} \right)$ | (\$17,350) = \$3,361.61 |
| Clock-radios | $\left( \frac{\$48,150}{\$181,675} \right)$ | (\$17,350) = \$4,598.33 |
| Other        | $\left( \frac{\$19,275}{\$181,675} \right)$ | (\$17,350) = \$1,840.77 |

RATIO AND PROPORTION  
Level 1

Clerical

B. Problems without Solutions

6. A logging crew cuts, loads, and trucks 9,300 board feet of timber to the mill in 3 days and continues to work at the same rate. On what day is the 150,000th board foot delivered to the mill?

Solution:

7. Apex Company granted wage increases to its employees. The monthly payroll rose from \$10,000 to \$12,000. Steve's wages, which had been \$575, rose in proportion. How much a month did he earn after the raise?

Solution:

8. If 9 yards of goods cost \$7.50, how many yards can be bought for \$50.00?

Solution:

9. If 6 yards of cloth cost \$5.25, what will 10 yards cost at the same rate?

Solution:

RATIO AND PROPORTION  
Level 1

Clerical

B. Problems without Solutions (continued)

10. A man receives \$14 for working 8 hrs. How much would he receive for working 50 hours, at the same rate of pay?

Solution:

11. A firm's expenses for 5 weeks amounted to \$1,600. At this rate what would the expenses amount to in a year?

Solution:

12. Gus Schwam, house-to-house canvasser, earns the same commission on each set of books he sells. In May he sold 18 sets, earning \$396. In June he sold 23 sets. How much did he earn in June?

Solution:

13. A retailer sells for \$40 an article that costs him \$25. At the same rate, what would be his selling price of an article that costs him \$35?

Solution:

RATIO AND PROPORTION  
Level 1

Clerical

B. Problems without Solutions (continued)

14. Carl Maynard, maintenance supervisor, drove to the plant Monday morning and found that the cellar was flooded to a depth of 18 inches. He turned on the pump and in 40 minutes the water level went down 1 1/2 inches. At this rate, how long did it take Carl to pump all the water out of the cellar?

Solution:

15. Mr. Davis has five employees to whom he pays a total of \$3,675 monthly.

Compute each employee's proportion of total payroll.

| <u>Employee</u> | <u>Monthly Salary</u> | <u>Proportion of<br/>Total Payroll</u> |
|-----------------|-----------------------|----------------------------------------|
| Johnson         | \$910.00              |                                        |
| Ascot           | 760.00                |                                        |
| Murphy          | 700.00                |                                        |
| Kent            | 680.00                |                                        |
| Alexander       | 625.00                |                                        |
|                 | <u>\$3,675.00</u>     | <u>                    </u>            |

Solution:



RATIO AND PROPORTION  
Level 1

Clerical

Complete Solutions to B Problems

6. 
$$\frac{3 \text{ days}}{9,300 \text{ board ft}} = \frac{d}{150,000 \text{ board ft}}$$
$$(9,300 \text{ board ft})d = 450,000 \text{ board ft} \times \text{day}$$
$$d = \frac{450,000 \text{ board ft} \times \text{day}}{9,300 \text{ board ft}}$$
$$d = 48 \text{ days}$$

7. 
$$\frac{\$10,000}{\$12,000} = \frac{\$575}{x}$$
$$10,000x = \$6,900,000 \quad x = \$690$$

8. 
$$\frac{9 \text{ yards}}{\$7.50} = \frac{x}{\$50}$$
$$(\$7.50)x = \$450 \text{ yards}$$
$$x = \frac{\$450 \text{ yards}}{\$7.50}$$
$$x = 60 \text{ yards}$$

9. 
$$\frac{6 \text{ yards}}{\$5.25} = \frac{10 \text{ yards}}{s}$$
$$(6 \text{ yards})s = \$52.50 \times \text{yards}$$
$$s = \frac{\$52.50 \times \text{yards}}{6 \text{ yards}} \quad s = \$8.75$$

10. 
$$\frac{\$14}{8 \text{ hr}} = \frac{x}{50 \text{ hr}}$$
$$(8 \text{ hr})x = \$700 \text{ hr}$$
$$x = \frac{\$700 \text{ hr}}{8 \text{ hr}}$$
$$x = \$87.50$$



RATIO AND PROPORTION  
Level 1

Clerical

Complete Solutions to B Problems (continued)

11. 
$$\frac{5 \text{ weeks}}{\$1,600} = \frac{52 \text{ weeks}}{x}$$
$$(5 \text{ weeks})x = \$83,200 \text{ weeks}$$
$$x = \frac{\$83,200 \text{ weeks}}{5 \text{ weeks}}$$
$$x = \$16,640$$

12. 
$$\frac{18 \text{ sets}}{\$396} = \frac{23 \text{ sets}}{m}$$
$$(18 \text{ sets})m = \$9,108 \text{ sets}$$
$$m = \frac{\$9,108 \text{ sets}}{18 \text{ sets}}$$
$$m = \$506$$

13. 
$$\frac{\$25}{\$40} = \frac{\$35}{c}$$
$$25c = \$1,400$$
$$c = \$56$$

14. 
$$\frac{40 \text{ min}}{1.5 \text{ in}} = \frac{x}{18 \text{ in}}$$
$$(1.5 \text{ in})x = 720 \text{ min(in)}$$
$$x = \frac{720 \text{ min(in)}}{1.5 \text{ in}}$$
$$x = 480 \text{ min} = 8 \text{ hrs}$$

15. 
$$\text{Johnson} \quad \frac{\$910}{\$3,675} = 0.2476$$
$$\text{Ascot} \quad \frac{\$760}{\$3,765} = 0.2968$$
$$\text{Murphy} \quad \frac{\$700}{\$3,765} = 0.1905$$
$$\text{Kent} \quad \frac{\$680}{\$3,675} = 0.1850$$
$$\text{Alexander} \quad \frac{\$625}{\$3,675} = 0.1701$$

A. Problems with Solutions

1. The flow into a trickling filter is 2.65 MGD. It has been calculated that this filter removes 4250 pounds of BOD each day. Most data at the plant is expressed in ppm. Express this BOD removal in ppm.

Solution:

One part per million is expressed in many different ways in different parts of a treatment plant. In the lab, it is generally mg/l, but that does us little good here. The ratio of one:million can be in pounds, gallons, or any other unit. Here, we will choose 1 gallon:1 million gallons.

1 gallon per million gallons = 8.34 pounds per million gal.

$(8.34 \text{ lbs/million gal})(2.65 \text{ MGD}) = 22.10 \text{ pounds needed for 1 ppm}$

B. Problems without Solutions

2. An aeration tank with a flow of 1.5 MGD has 120 ppm BOD in the primary effluent and uses 800,000 cubic feet of air per day. How many pounds of air are used per pound of applied BOD?

B. Problems without Solutions (continued)

3. The Minto Island treatment plant has a raw sewage flow of 2.35 MGD. Trickling filter effluent is recirculated in this plant at the rate of 2.6 MGD. What is the ratio of trickling filter effluent to plant influent?
  
  
  
  
  
  
  
  
  
  
4. The chlorinator is set to feed at 200 pounds per day. You run a test of the effluent and find a residual of 0.54. You wish to carry a chlorine residual of 1.0 in this effluent and so must increase the feed in the chlorinator. You check the flow and find that raw sewage is entering at 2.75 MGD. What should the new setting on the chlorinator be to carry the desired residual?
  
  
  
  
  
  
  
  
  
  
5. How many pounds of chlorine are needed to treat a 12.25 MGD effluent with a chlorine demand of 17 mg/liter?
  
  
  
  
  
  
  
  
  
  
6. With the chlorinator set to feed 60 pounds per day, the chlorine residual after the OT test is 0.5 mg/l. If the average sewage flow is 0.945 MGD, what is the chlorine demand of the wastewater?



B. Problems without Solutions (continued)

7. The purpose of pump station #8 is to lift sewage from a wet well at sea level to a gravity collection system situated at the top of a cliff. The station contains two 1720 gpm centrifugal pumps that operate alternately to empty the wet well. There is a four foot vertical difference between the starting sensor and the pump intakes. A check list is reproduced in part below.

| date    | time       | Pump #1    |     |       | Pump #2    |     |       |
|---------|------------|------------|-----|-------|------------|-----|-------|
|         |            | hour meter | run | count | hour meter | run | count |
| July 14 | 11:00 a.m. | 9803.6     | --- | 0     | 8275.3     | --- | 0     |
| July 15 | 11:00 a.m. | 9805.2     | 1.6 | 16    | 8276.9     | 1.6 | 16    |

- What was the total pumping time (run) for the 24 hour period?
- How much sewage was pumped from the wet well to the gravity collection system during the 24 hour period?  
How much was pumped, expressed as MGD?
- How many gallons of sewage accumulate in the wet well before the well is pumped down?
- When asked about the horizontal dimensions of the wet well, the operator thought the well was 15' by 20'. How close was his answer?

Solution:

Complete Solutions to B Problems

2.  $1 \text{ mg/l} = 1 \text{ ppm}$  so,  $120 \text{ mg/l} = 120 \text{ ppm}$

Pounds applied = (flow) (8.34) (ppm)

$$= (1.5) (8.34) (120) = 1,501.2$$

So cubic feet of air to pounds applied is:

$$\frac{800,000}{1,501.2} = \frac{533}{1}$$

3. Simple decimal division:

$$\frac{2.6 \text{ MGD}}{2.35 \text{ MGD}} = 1.11$$

4. You would like to increase the residual  $1.0 - 0.04 = 0.96 \text{ ppm}$

1 gal : 1 million gal

1 ppm = 8.34 lbs/MGD

$$(0.96) (8.34 \text{ lbs/MGD}) (2.75 \text{ MGD}) = 22.0176 \text{ lbs}$$

5.  $17 \text{ mg/l} = 17 \text{ ppm}$

1 ppm = 8.34 pounds/MGD

$$(17) (8.34) (12.25) = 1,736.805 \text{ pounds}$$

6. We have a chlorine residual, so, we are applying more chlorine than needed.

$$0.5 \text{ mg/l} = 0.5 \text{ ppm} = 0.5 \times 8.34 \text{ pounds/MGD}$$

$$(0.5) (8.34) (0.945) = 3.94 \text{ pounds extra chlorine}$$

$$\text{Thus, } 60 - 3.94 = 56 \text{ pounds needed.}$$

$$\frac{56.06}{(0.945) (8.34)} = 7.11 \text{ ppm}$$



Complete Solutions to B Problems (continued)

7. (a) The pumps operate alternately, not simultaneously. The total pumping time is
- $$1.6 \text{ hrs} + 1.6 \text{ hrs} = 3.2 \text{ hrs}$$
- (b)  $(3.2 \text{ hrs/day})(60 \text{ min/hr})(1,720 \text{ gal/min}) = 330,240 \text{ gal/day}$   
expressed in MGD = 0.33 MGD
- (c) The total number of pumping cycles is 32 (16 counts for pump #1 + 16 counts for pump #2.) The quantity pumped out equals the quantity accumulated between pumpings.
- $$(3.2 \text{ hrs})(60 \text{ min/hr}) = 192 \text{ min}$$
- $$\frac{192 \text{ min}}{32 \text{ cycles}} = 6 \text{ min/cycle}$$
- $$(6 \text{ min/cycle})(1,720 \text{ gal/min}) = 10,320 \text{ gal/cycle}$$
- (d) The vertical distance (between the starting sensor and the pump intakes) is 4 foot.

$$\frac{10,320 \text{ gal}}{7.5 \text{ gal/cu ft}} = 1,376 \text{ cu ft}$$

$$\frac{1,376 \text{ cu ft}}{4 \text{ ft}} = 344 \text{ sq ft}$$

$$(15 \text{ ft})(20 \text{ ft}) = 300 \text{ sq ft}$$

The area of the well is 44 sq ft greater than the operator's estimate.

A. Problems with solutions.

1. Soil bulk density is 1.56. What is the weight of one acre inch of this soil if water weighs 62.4 lbs. per cubic foot?

Solution:

$$\frac{1.56}{1} = \frac{W}{\frac{62.4 \text{ lbs.}}{\text{ft.}^3}}$$

$$(1.56) \left( \frac{62.4 \text{ lbs.}}{\text{ft.}^3} \right) = (W) (1)$$

$$\frac{97.3 \text{ lbs.}}{\text{ft.}^3} = W$$

2. How fast would a silage blower with a 8-in. pulley be operating when connected to a 5-inch pulley on a P.T.O. turing at 1,600 rpm?

Solution:

$$\frac{5 \text{ in.}}{8 \text{ in.}} = \frac{N}{1,600 \text{ rpm}}$$

$$(5 \text{ in.}) (1,600 \text{ rpm}) = (8 \text{ in.}) (N)$$

$$\frac{(5 \text{ in.}) (1,600 \text{ rpm})}{8 \text{ in.}} = N = 1,000 \text{ rpm}$$

3. If a certain cylindrical tank is known to hold 1,000 gal. when full, what is the capacity of a similar tank of the same length and twice the diameter?

Solution:

$$V = \pi \frac{d^2}{4} h$$

$$\frac{1,000 \text{ gal}}{\frac{\pi d^2 h}{4}} = \frac{A}{\frac{\pi (2D)^2 h}{4}}$$

$$1000 \text{ gal.} = \frac{\pi D^2 h}{4}$$

$$(1,000 \text{ gal.}) \left( \frac{\pi}{4} \right) \frac{(4 D^2) h}{4} = A \left( \frac{\pi D^2 h}{4} \right)$$

$$\frac{(1,000 \text{ gal}) \left( \frac{\pi}{4} \right) (4 D^2) (h)}{\frac{\pi D^2 h}{4}} = A$$

$$4,000 \text{ gals.} = A$$

B. Problems without solutions.

4. One of two meshing spur gears on adjoining shafts has 24 teeth and the other has 16 teeth. How fast is the 16-tooth gear turning when the 24-tooth gear is making 1,800 rpm's?
  
  
  
  
  
  
  
  
  
  
5. What size gear is needed to turn the reel on a harvester at 24 rev/min when it is driven by a chain on a 18-tooth power gear turning at 120 rev/min.?
  
  
  
  
  
  
  
  
  
  
6. A planter plate turns  $\frac{1}{2}$  revolution for each revolution of the ground wheel. The ground wheels have an effective circumference of 80 inches, the plate has 16 edge drop cells. What is the spacing in the row for drilled corn?

7. Two machine pulleys, 18 in. and 5 inches in diameter, respectively, are connected by a belt. Find the speed of the smaller when the larger is making 270 rpm? (The ratio of their speeds is equal to the inverse ratio of their diameters).

8. If 1 gal. 3 qts. 1 pint of spray is applied to .4 acres, what is the rate of application in gallons per acre?
9. How many pounds of fertilizer should be applied to a rectangular garden measuring 80 ft. x 75 ft., if the recommended rate of distribution is 560 lbs. per acre?



B. Problems without solutions, continued.

10. Allowing 6.8 lbs. of concentrate per pound of gain, how many ton of concentrate would be needed to put 540 lbs. of gain on 250 head of cattle?

11. If a beef animal that is fed a daily ratio of 2.1 lbs. of cottonseed meal, 8 lbs. of corn and 12 lbs. of prairie hay gains 2.4 lbs. daily, how much of each of these feeds should be required to produce 1,000 lbs. of live weight?



12. If  $1\frac{1}{2}$  ft.<sup>3</sup> of cement,  $2\frac{3}{4}$  ft.<sup>3</sup> of sand and  $6\frac{1}{4}$  ft.<sup>3</sup> of gravel are needed to make 8 ft.<sup>3</sup> of concrete, how much of each would be needed to make 125 ft.<sup>3</sup> of concrete?

RATIO & PROPORTION  
Level I

Agriculture

complete solutions to B problems.

$$4. \frac{R_1}{R_2} = \frac{N_2}{N_1} \qquad \frac{R_1}{1,800 \text{ rpm}} = \frac{24 \text{ teeth}}{16 \text{ teeth}}$$

$$(16 \text{ teeth}) (R_1) = (24 \text{ teeth}) (1,800 \text{ rpm})$$

$$R_1 = \frac{(24 \text{ teeth}) (1,800 \text{ rpm})}{16 \text{ teeth}} = 2,700 \text{ rpm}$$

$$5. \frac{N}{120 \text{ rev/min}} = \frac{18 \text{ tooth}}{24 \text{ rev/min}}$$

$$(24 \text{ rev/min}) (N) = (18 \text{ tooth}) (120 \text{ rev/min})$$

$$N = \frac{(18 \text{ teeth}) (120 \text{ rev/min.})}{24 \text{ rev/min.}} = 90 \text{ teeth}$$

$$6. \frac{1/2}{1} = \frac{N}{16}$$

$$N (1) = 16 \text{ seeds } (1/2)$$

$$= 8 \text{ seeds}$$

$$\frac{8 \text{ seeds}}{80 \text{ inches}} = \frac{1 \text{ seed}}{D}$$

$$8 \text{ seeds } (D) = (1 \text{ seed}) (80 \text{ inches})$$

$$D = \frac{(1 \text{ seed}) (80 \text{ inches})}{8 \text{ seeds}}$$

$$D = 10 \text{ inches}$$

$$7. \frac{R_L}{R_S} = \frac{d_s}{d_1}$$

$$\frac{270 \text{ rpm}}{R_S} = \frac{5 \text{ in.}}{18 \text{ in.}}$$

$$\frac{(270 \text{ rpm}) (18 \text{ in.})}{5 \text{ in.}} = (5 \text{ in.}) R_S$$

$$\frac{(270 \text{ rpm}) (18 \text{ in.})}{5 \text{ in.}} = R_S = 972 \text{ rpm}$$

$$8. (1 \text{ gal}) \left( \frac{8 \text{ pt.}}{1 \text{ gal}} \right) = 8 \text{ pt.}$$

$$(3 \text{ qt.}) \left( \frac{2 \text{ pt.}}{1 \text{ qt.}} \right) = 6 \text{ pt.}$$

$$1 \text{ pt.} = \frac{1 \text{ pt.}}{1}$$

$$\text{Total} = 15 \text{ pt.}$$

$$\frac{15 \text{ pt.}}{.4A} = \frac{R}{1A}$$

$$(15 \text{ pt.}) (1 A) = R (.4 A)$$

$$\frac{15 \text{ pt. } (1A)}{.4A} = R = (37.5 \text{ pt.}) \left( \frac{1 \text{ gal}}{8 \text{ pt.}} \right) = 4 \frac{11}{16} \text{ gal.}$$

RATIO & PROPORTION  
Level I

Agriculture

Complete solutions to B problems, continued.

9. Area ; (80 ft.) (75 ft.) = 6000 ft.<sup>2</sup>

$$\frac{560 \text{ lbs}}{\text{Acre}} = \frac{560 \text{ lbs}}{43,560 \text{ ft.}^2} = \frac{A}{6,000 \text{ ft.}^2}$$

$$(560 \text{ lbs.}) (6,000 \text{ ft.}^2) = (43,560 \text{ ft.}^2) (A)$$

$$\frac{(560 \text{ lbs.}) (6,000 \text{ ft.}^2)}{43,560 \text{ ft.}^2} = A = 77.1 \text{ lbs.}$$

10. Total gain:

$$\left( \frac{540 \text{ lbs}}{\text{head}} \right) (250 \text{ head}) = 135,000 \text{ lbs.}$$

$$\frac{6.8 \text{ lbs}}{1 \text{ lb.}} = \frac{N}{135,000 \text{ lbs}}$$

$$\frac{(135,000 \text{ lbs.}) (6.8 \text{ lbs.})}{1 \text{ lb.}} = N = (918,000 \text{ lbs.}) \left( \frac{1 \text{ ton}}{2,000 \text{ lbs.}} \right)$$

$$= 459 \text{ ton.}$$

11. Cottonseed meal:

$$\frac{2.1 \text{ lbs.}}{N} = \frac{2.4 \text{ lbs}}{1,000 \text{ lbs.}}$$

$$(2.1 \text{ lbs.}) (1,000 \text{ lbs.}) = N (2.4 \text{ lbs.})$$

$$\frac{(2.1 \text{ lbs.}) (1,000 \text{ lbs.})}{(2.4 \text{ lbs.})} = N = 875 \text{ lbs.}$$

Corn:

$$\frac{8 \text{ lbs.}}{N} = \frac{2.4 \text{ lbs}}{1,000 \text{ lbs.}}$$

$$(8 \text{ lbs.}) (1,000 \text{ lbs.}) = (2.4 \text{ lbs.}) N$$

$$\frac{(8 \text{ lbs.}) (1,000 \text{ lbs.})}{(2.4 \text{ lbs.})} = N = 3333 \text{ lbs.}$$

Prairie Hay:

$$\frac{12 \text{ lbs}}{N} = \frac{2.4 \text{ lbs.}}{1,000 \text{ lbs.}}$$

$$(12 \text{ lbs.}) (1,000 \text{ lbs.}) = (2.4 \text{ lbs.}) (N)$$

$$\frac{(12 \text{ lbs.}) (1,000 \text{ lbs.})}{2.4 \text{ lbs.}} = N = 5,000 \text{ lbs.}$$

RATIO & PROPORTION  
Level I

Agriculture

Complete solutions to B problems, continued.

12. Cement:

$$\frac{1 \frac{1}{2} \text{ ft.}^2}{8 \text{ ft.}^3} = \frac{A}{125 \text{ ft.}^3}$$

$$(125 \text{ ft.}^3) (3/2 \text{ ft.}^3) = (8 \text{ ft.}^3) (A)$$

$$\frac{(125 \cancel{\text{ft.}^3}) (3/2 \text{ ft.}^3)}{8 \cancel{\text{ft.}^3}} = A = 23 \frac{7}{16} \text{ ft.}^3 \approx 23 \frac{1}{2} \text{ ft.}^3$$

Sand:

$$\frac{2 \frac{3}{4} \text{ ft.}^3}{8 \text{ ft.}^3} = \frac{A}{125 \text{ ft.}^3}$$

$$(125 \text{ ft.}^3) (2 \frac{3}{4} \text{ ft.}^3) = (8 \text{ ft.}^3) (A)$$

$$\frac{(125 \cancel{\text{ft.}^3}) (11/4 \text{ ft.}^3)}{8 \cancel{\text{ft.}^3}} = A = 42 \frac{31}{32} \text{ ft} \approx 43 \text{ ft.}^3$$

Gravel:

$$\frac{6 \frac{1}{4} \text{ ft.}^3}{8 \text{ ft.}^3} = \frac{A}{125 \text{ ft.}^3}$$

$$(125 \text{ ft.}^3) (6 \frac{1}{4} \text{ ft.}^3) = (8 \text{ ft.}^3) (A)$$

$$\frac{(125 \cancel{\text{ft.}^3}) (25/4 \text{ ft.}^3)}{8 \cancel{\text{ft.}^3}} = A = 97 \frac{21}{32} \approx 97 \frac{1}{2} \text{ ft.}^3$$



RATIO AND PROPORTION  
Level 1

Fire and Police Science

A. Problems with Solutions

1. In recording the crime scene the recommended scales are 1/2 inch equals 1 foot in ordinary rooms. What would be the size of the room 24' 6" by 15' in the investigating officers drawing?

Solution:

You need to set up two proportions using the ratio 1/2 inch to 1 foot.

$$\frac{1/2 \text{ inch}}{x \text{ inches}} = \frac{1 \text{ foot}}{24 \text{ ft } 6 \text{ in}}$$

$$\frac{0.5 \text{ inch}}{x \text{ inches}} = \frac{1 \text{ Ft}}{24.5 \text{ Ft}}$$

$$x = 12.25 \text{ inches}$$

$$\frac{1/2 \text{ inch}}{x \text{ inches}} = \frac{1 \text{ foot}}{15 \text{ feet}}$$

$$\frac{0.5 \text{ inch}}{x \text{ inches}} = \frac{1 \text{ Foot}}{15 \text{ Feet}}$$

$$x = 7.50 \text{ inches}$$

The dimensions of the drawing will be  
12 1/4 inches by 7 1/2 inches

B. Problems without Solutions

2. The population of the District of Columbia in 1970 was 756,510 with 4,582 police officers. What was the number of police officers per 1000 population?



RATIO AND PROPORTION  
Level 1

Fire and Police Science

B. Problems without Solutions (continued)

3. If the pressure of a column of water 27" high is 1 lb/in , what is the pressure caused by a column of water 520 feet high?

4. While investigating the disappearance of a sixteen year old girl, the officers found two sets of footprints leading from a side road across a field of loose dirt to a wooded area where the tracks were lost. On investigation, the tracks leading into the woods were found to be deeper than those leading out of the woods. One of the officers measured 8 prints going and coming and then compared them to 8 prints of his own. The officer weighed 180 lbs. On the basis of the measurements given below, what would the estimated weight be going into the woods and the estimated weight of the person when returning? Would this evidence cause the officer to investigate the woods further?

| <u>Officer</u> |        | <u>Prints Leading to Woods</u> |        | <u>Return Prints</u> |        |
|----------------|--------|--------------------------------|--------|----------------------|--------|
| 1 1/4"         | 1 1/8" | 1 3/4"                         | 1 1/2" | 7/8"                 | 1"     |
| 1 3/8"         | 1 1/4" | 1 5/8"                         | 1 7/8" | 3/4"                 | 1 1/8" |
| 7/8"           | 7/8"   | 1 7/8"                         | 1 7/8" | 1 1/8"               | 1"     |
| 1"             | 1 1/4" | 1 3/4"                         | 1 3/4" | 1 1/8"               | 1"     |
| Average 1 1/8" |        | 1 3/4"                         |        | 1"                   |        |

Complete Solutions to B Problems

2. You need to form a ratio between the number of police officers and the total population, and set that equal to the unknown number of police officers per 1000 people.

$$\frac{4,582 \text{ policemen}}{756,510 \text{ people}} = \frac{x \text{ policemen}}{1000 \text{ people}} \quad \text{now cross multiply}$$

$$(756,510)(x) = 4,582,000 \quad \text{divide both sides by 756,510}$$

$$x = 6.06 \quad \text{So there are about 6 policemen per 1000 people}$$

3. You need to set the ratio of 27 inches to 1 lb/sq in equal to a ratio of 520 feet to the unknown pressure. First change 520 ft to inches.

$$(520 \text{ feet})(12 \text{ in/foot}) = 6,240 \text{ inches}$$

$$\frac{27 \text{ inches}}{6,240 \text{ inches}} = \frac{1 \text{ lb/sq in}}{x \text{ lb/sq in}} \quad \text{cross multiply}$$

$$(27)(x) = 6,240 \quad \text{divide both sides by 27}$$

$$x = 231.11 \quad \text{A column of water 520 ft high has a pressure of 231.11 lbs/sq in}$$

4. You need to compare the average depth of the footprints to the weights of the officer, the person going into the woods, and the person returning from the woods.

For the person going into the woods

$$\frac{1 \frac{1}{8} \text{ inches}}{1 \frac{3}{4} \text{ inches}} = \frac{180 \text{ lb}}{x \text{ lb}}$$

$$\frac{1.125 \text{ inches}}{1.75 \text{ inches}} = \frac{180 \text{ lb}}{x \text{ lb}} \quad \text{cross multiply}$$

$$315 = 1.125x \quad \text{divide both sides by 1.125}$$

$$280 = x \quad \text{Therefore, the weight of the person going in is about 280 lbs}$$

RATIO AND PROPORTION  
Level 1

Fire and Police Science

Complete Solutions to B Problems (continued)

4. (continued)

For the person coming out of the woods.

$$\frac{1 \frac{1}{8} \text{ in}}{1 \text{ inch}} = \frac{180 \text{ lb}}{x \text{ lb}}$$

$$\frac{1.125}{1} = \frac{180 \text{ lb}}{x \text{ lb}} \quad \text{cross multiply}$$

$$180 = 1.125x$$

$$160 = x$$

Therefore, the weight of the person coming out is 160 lb. The difference between these two weights is 120 lbs, and since this could be the weight of the girl, the investigation should continue.



RATIO AND PROPORTION  
Level I

Industrial, Electrical and  
Hydraulics

A. Problems with solutions

1. On a voltmeter, a scale graduated from 0 to 120 is used for three voltage ranges; 0-750V and 0-120V. When the selector switch is set to the 0-750V range and the needle reads 112, what is the actual voltage?

Solution:

$$\frac{750V}{120V} = \frac{x}{112}$$

$$x = \frac{(750)(112)V}{120} = \underline{\underline{700 \text{ volts}}}$$

Level II

2. A coil of #10AWG conductor shows a measured resistance of 2.13 ohms. What is the length of wire on the coil if #10AWG wire has a resistance of 1 ohm per 1000 feet?

Solution:

Ratio and proportion method  
Let L = the coil wire length

$$\text{Then } \frac{L}{1000 \text{ Ft.}} = \frac{2.13 \text{ ohms}}{1 \text{ ohm}}$$

$$L = \frac{(1000 \text{ ft}) (2.13 \text{ ohms})}{1 \text{ ohm}} = \underline{\underline{2130 \text{ feet}}}$$

Ans.

Conversion factor method

$$(2.13 \text{ ohms}) \left( \frac{1000 \text{ ft}}{1 \text{ ohm}} \right) = 2130 \text{ feet}$$

Ans.

B. Problems without solutions  
Level I

3. If the allowable current density for copper bus bars is 1000 amperes per square inch, what is the current carrying capacity of a circular copper bus bar of  $\frac{3}{4}$  inch diameter?

RATIO AND PROPORTION  
Level I

Industrial, Electrical and  
Hydraulics

B. Problems without solutions

4. If a current transformer has a ratio of 100:5 and an ammeter connected to its secondary winding reads 1.5 amperes, what is the line current?
  
  
  
  
  
  
  
  
  
  
5. One foot of a certain nichrome wire has a resistance of 1.63 ohms. To make a heating element that will use 5 amperes at 115 volts, what length wire is needed?

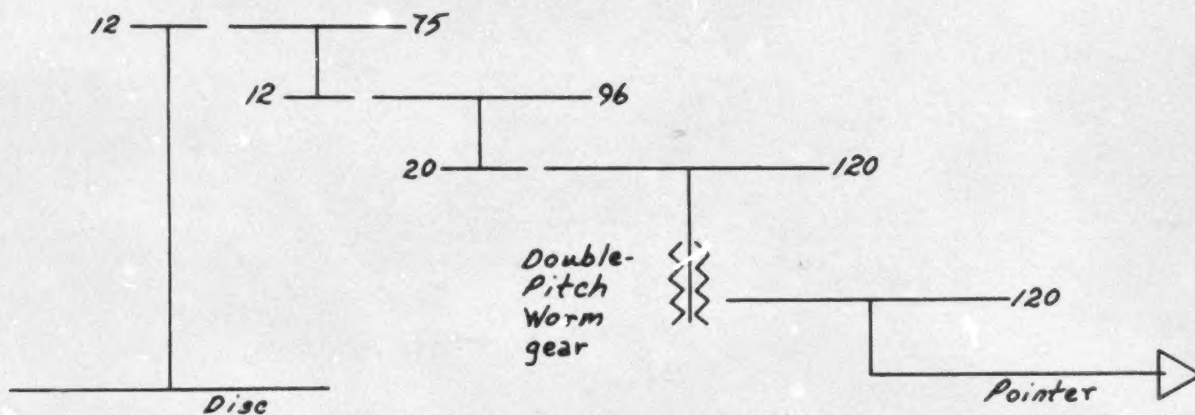
Level II

6. A 100 ampere, 15 kilovolt oil switch with a maximum 5 ampere trip coil is used to control a current transformer rated 100-5 A. What should the switch trip coil be set at in order to open the switch at 85 ampere line current?



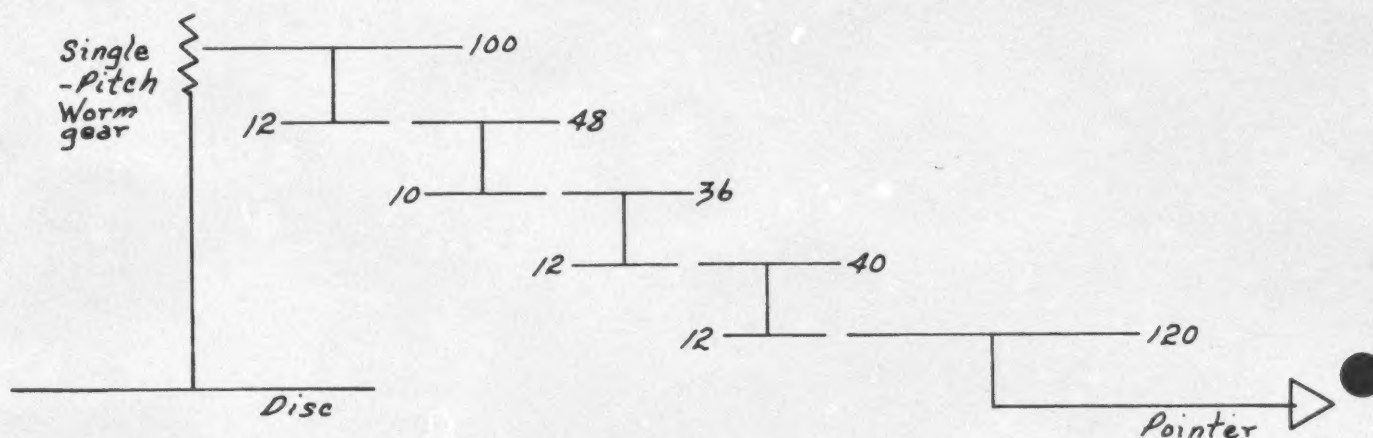
B. Problems without Solutions

7. A watthour meter has a gear train as diagrammed below. How many disc revolutions cause one revolution of the pointer?



B. Problems without Solutions

8. A watt-hour meter repairman often must use parts from one style of meter to repair another style. To be certain gear ratios are not changed when interchanging parts, he must be able to calculate gear ratios for all possible gear arrangements. You are to calculate the Gear Ratio ( $R_g$ ) of the following gear train and determine how many revolutions of the disc cause one revolution of the pointer. (Note: One revolution of a single-pitch worm gear turns the mating pinion gear one tooth only)



RATIO AND PROPORTION  
Level I

Industrial, Electrical and  
Hydraulics

Complete solutions to B problems

$$3. \quad \frac{1000a}{x} = \frac{1 \text{ in}^2}{\pi \left(\frac{3}{4} \text{ in.}\right)^2}$$

$$x = \frac{(1000A) \left(\frac{\pi}{4}\right) \left(\frac{3}{4} \text{ in.}\right)^2}{1 \text{ in}^2} = 441.79A \quad \underline{\underline{442 \text{ Amperes}}}$$

Alternate solution:

Considering current density of  $\frac{1000a}{\text{in.}}$  as a conversion factor:

$$\left(\frac{1000A}{\text{in}^2}\right) \pi \left(\frac{3}{8} \text{ in.}\right)^2 = 441.79A \quad \underline{\underline{442 \text{ amperes}}}$$

$$4. \quad \frac{\text{Line current}}{\text{Secondary current}} = \frac{\text{Primary}}{\text{Secondary}}$$

$$\frac{C_L}{1.5A} = \frac{100}{5}$$

$$C_L = \frac{(1.5A)(100)}{5} = 3 \text{ Amperes}$$

$$5. \quad \text{Heating coil resistance } R = \frac{E}{I} = \frac{115v}{5A} = 23 \text{ ohms}$$

$$\frac{\text{wire resistance}}{\text{coil resistance}} = \frac{1 \text{ foot wire}}{\text{length of coil wire}}$$

$$\frac{1.63\Omega}{23\Omega} = \frac{1 \text{ ft.}}{L}$$

$$L = \frac{23}{1.63} \text{ ft.} = 14.11 \text{ ft.}$$

Level II

$$6. \quad \frac{5A}{100A} = \frac{\text{Coil amperage}}{85A}$$

$$\text{Coil amperage} = \frac{(5)(85)}{100} A = 4.25A$$

$$7. \quad \left(\frac{12}{75}\right) \left(\frac{12}{96}\right) \left(\frac{20}{120}\right) \left(\frac{2}{120}\right) = \frac{1}{18,000}$$

Thus 18,000 revolutions of the disc causes one printer revolution.

Complete solutions to B problems

8. In a compound gear train, the ratio of input to output rpm is equal to the product of all the ratios in the train.

$$\left(\frac{1}{100}\right)\left(\frac{12}{48}\right)\left(\frac{10}{36}\right)\left(\frac{12}{40}\right)\left(\frac{12}{120}\right) = \frac{1}{48,000} = \text{Input-output rpm ratio}$$

Thus it takes 48,000 revolutions of the disc to turn the pointer one complete revolution.



A. Problems with Solutions

1. The references show the relationships existing between the number of turns (in the windings) and the voltages in the primary and secondary (s) of a transformer. A 115 Volt, 60 HERTZ, power transformer has a primary consisting of 300 turns and a secondary voltage of 12.6 volts. The transformer also has a second secondary supplying 350 volts. How many turns exist:

(a) In the 12.6 volt winding? Round to the nearest turn.

(b) In the 350 volt winding? Round to the nearest turn.

Ref:  $V_s = \frac{V_p}{a}$  Where:  $V_s$  = Secondary Voltage,  $V_p$  = Primary Voltage  
and  $a$  = the turns ratio:  $a = \frac{\text{turns in primary, } N_p}{\text{turns in secondary, } N_s}$

Solution:

- (a) Finding the turns ratio for the 12.6 V winding:

$$V_s = \frac{V_p}{a} \quad a = \frac{V_p}{V_s} = \frac{115 \text{ volts}}{12.6 \text{ volts}} = 9.13$$

Finding the turns for the 12.6 V winding:

$$a = \frac{N_p}{N_s} \quad N_s = \frac{N_p}{a} = \frac{300}{9.13} = 33 \text{ turns}$$
$$N_s = 33 \text{ turns}$$

- (b) Finding the turns ratio for the 350 Volt winding:

$$a = \frac{V_p}{V_s} = \frac{115}{350} = 0.383$$

Finding the turns for the 350 Volt winding:

$$a = \frac{N_p}{N_s} \quad N_s = \frac{N_p}{a} = \frac{300}{0.383} = 783 \text{ turns}$$

$$N = 783 \text{ turns}$$



B. Problems without Solutions

2. The output voltage regulation of a power supply is defined as the ratio of the difference between its no-load and full-load voltage to the full load voltage and is usually expressed as a percentage. This unit has a no-load output voltage rating of 250 VDC. If the unit is supplying full load current and the output voltage is accurately measured to be 247.5 volts, what is its regulation?
  
  
  
  
  
  
  
  
  
  
3. The American Wire Gage (AWG) system sizes wire from #0000, the largest, through #40, the smallest. The gage numbers were carefully chosen such that for a change of 3 gage numbers (eg. from #10 to #13), the resistance of a given length of the wire either doubles (higher gages) or is cut in half (lower gage numbers). Number 10 copper wire provides a good reference point, since its resistance is very nearly 1 OHM per 1000 feet. Determine the resistance of 1000 feet of the following copper wire sizes:  
  
(a) #16 AWG; (b) #7 AWG; (c) #40 AWG
  
  
  
  
  
  
  
  
  
  
4. The power gain of a transistor circuit is defined as the ratio of output power ( $P_{out}$ ) to input power ( $P_{in}$ ). An RCA SK-2015 transistor in an audio power amplifier circuit has an input power of 0.51 watts and a power gain of 30.  
  
(a) What is the output power available at the speaker?  
(b) If the volume control were changed to reduce the input power by a ratio 3:1, what would be the new power delivered to the speaker?

B. Problems without Solutions (continued)

5. The resistance of a copper conductor changes with temperature as is indicated by the reference. Voltage and current measurements taken on the secondary of a step-up transformer indicate that the resistance of the copper winding is increasing from 100 OHMS at room temperature (68 F) to 128.8 OHMS at its operating temperature (200 F). Determine the thermal constant of proportionality K for copper wire.

Ref:  $R_{T_2} = R_{T_1} [1 + K (T_2 - T_1)]$  where:  $R_{T_2}$  = Resistance at new temperature;  $R_{T_1}$  = Resistance at original temperature;  $T_1$  = original temperature;  $T_2$  = New temperature and K = Thermal constant of proportionality.

6. The force of repulsion between the negative electrostatic charges in free space is a function of the inverse square law as indicated by the reference. If two charges,  $Q_1$  and  $Q_2$ , are separated by a distance r, producing a force F, what change in force would occur if both charges were doubled and their separation was out in half?

Ref:  $F = \frac{1}{4 \pi \epsilon} \times \frac{Q_1 Q_2}{r^2}$  where: F = Force in Newtons;  $Q_1$  and  $Q_2$  are the two charges in coulombs (1 coulomb =  $6.28 \times 10^{18}$  electrons); r is the separation of the charges in meters and  $\epsilon$  is a constant of proportionality called permittivity. For free space,  $\epsilon = \frac{1}{36\pi \times 10^9}$

Complete Solutions to B Problems

$$2. \quad \text{Regulation} = \frac{250 - 247.5}{247.5} = 0.01$$

$$\text{Regulation} = 1\%$$

$$3. \quad (a) \quad \#10 = 1 \text{ OHM}; \#16 = 2 \times 3 \text{ Gage \#s} = (2)(2) = 4 \text{ OHMS/1000'}$$

$$(b) \quad \#10 = 1 \text{ OHM}; \#7 = 1 \times 3 \text{ Gage \#s} = (1)(1/2) = 0.5 \text{ OHMS/1000'}$$

$$(c) \quad \#10 = 1 \text{ OHM}; \#40 = 10 \times 3 \text{ Gage \#s} \\ = (2)(2)(2)(2)(2)(2)(2)(2)(2)(2) \\ = 1024 \text{ OHMS/1000'}$$

$$4. \quad (a) \quad \text{Power Gain} = \frac{P_{out}}{P_{in}} = 30$$

$$P_{out} = 30 P_{in} = 30 \times 0.51 \text{ watts} \\ = 15.3 \text{ watts}$$

$$(b) \quad P_{in_2} = \frac{P_{out}}{3} = \frac{0.51}{3} = 0.17 \text{ watts}$$

$$P_{out} = P_{in_2} \times 30 = 0.17 \times 30 = 5.1 \text{ watts}$$

$$P_{out} = 5.1 \text{ watts}$$

$$5. \quad R_{T_2} = R_{T_1} [1 + K (T_2 - T_1)]$$

Inserting values:

$$128.8 = 100 [1 + K (200 - 68)] \\ = 100 + K (100 \times 200 - 100 \times 68) \\ = 100 + 13,200K$$

Solving for K:

$$K = \frac{128.8 - 100}{13,200} = 0.00218$$

$$6. \quad \frac{F_1}{F_2} = \frac{\left(\frac{1}{4\pi\epsilon_0}\right)\left(\frac{Q_1 Q_2}{r^2}\right)}{\left(\frac{1}{4\pi\epsilon_0}\right)\left(\frac{2Q_1 \cdot 2Q_2}{(1/2r)^2}\right)} = \frac{\frac{1}{r^2}}{\frac{4}{1/4r^2}} = \left(\frac{1}{r^2}\right)\left(\frac{1/4r^2}{4}\right) = \frac{1/4}{4} = \frac{1}{16}$$

$$F_2 = 16 F_1$$



A. Problems with Complete Solutions

1. A lathe operator turns 9 brass bushings in 2 hrs 15 min. At the same rate, how many can be finished in an 8 hour day?

Solution:

$x$  = number of bushings in an 8 hour day

$$\frac{x}{9 \text{ bushings}} = \frac{8 \text{ hr}}{2 \text{ hr } 15 \text{ min}}$$

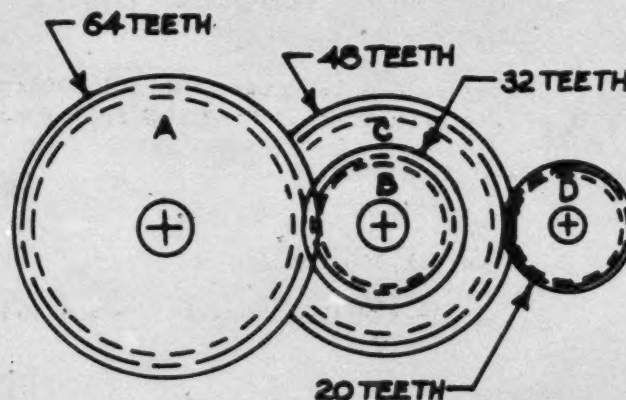
$$\frac{x}{9 \text{ bushings}} = \frac{8 \text{ hr}}{2.25 \text{ hr}}$$

$$(2.25)x = 72 \text{ bushings}$$

$$x = 32 \text{ bushings}$$

Note: Compare like quantities, and compare large to small in both fractions or compare small to large in both fractions.

2. A machinist wishes to replace gear D with a gear that will make 960 rpm. How many teeth must the new gear have? (rpm of gear A is 320)



Solution:

Going through the gear train two gears at a time

$$\text{rpm of gear B: } \frac{B}{320 \text{ rpm}} = \frac{64 \text{ teeth}}{32 \text{ teeth}} \quad B = 640 \text{ rpm}$$

rpm of gear C = rpm of gear B since they are on the same shaft

$$\text{rpm of gear D is 960, so } \frac{D}{48 \text{ teeth}} = \frac{640 \text{ rpm}}{960 \text{ rpm}}$$

$$D = 32 \text{ teeth}$$

Note: Gear problems involve inverse proportions

A. Problems with Complete Solutions (continued)

Alternate solution to problem 2:

If gear 1 drives gear 2, the rpm of gear 2 is given by:

$$\text{rpm of gear 2} = (\text{rpm of gear 1}) \left( \frac{\text{gear 1}}{\text{gear 2}} \right)$$

Note: The ratio of  $\frac{\text{gear 1}}{\text{gear 2}}$  is a ratio of  $\frac{\text{drive}}{\text{driven}}$

$$\text{rpm of D} = (\text{rpm of A}) \left( \frac{\text{gear A}}{\text{gear B}} \right) \left( \frac{\text{gear C}}{\text{gear D}} \right)$$

let D = teeth in gear D

$$960 \text{ rpm} = (320 \text{ rpm}) \left( \frac{64 \text{ teeth}}{32 \text{ teeth}} \right) \left( \frac{48 \text{ teeth}}{D} \right)$$

$$960 \text{ rpm} = \frac{(320 \text{ rpm})(64)(48 \text{ teeth})}{32D}$$

$$D = \frac{(320 \text{ rpm})(64)(48 \text{ teeth})}{(32)(960 \text{ rpm})} = 32 \text{ teeth}$$

Note: the ratio  $\frac{\text{gear B}}{\text{gear C}}$  was not included since they are on the same shaft

3. A 9" pulley on a drill press makes 1,350 rpm. It is belted to a 5" pulley on a motor. Find the rpm of the motor.

Solution:

$$\frac{5 \text{ in}}{9 \text{ in}} = \frac{x}{1,350 \text{ rpm}}$$

x = rpm of motor

$$x = \frac{5(1,350 \text{ rpm})}{9}$$

$$x = 2430 \text{ rpm}$$

B. Problems without Complete Solutions

4. A piece of  $1 \frac{3}{4}$ " round stock is required to mill a hexagonal bar  $1 \frac{1}{2}$ " across the flats. What size stock is needed for a bar  $2 \frac{1}{2}$ " across the flats? (Stock is available in  $\frac{1}{4}$ " sizes)

Solution:

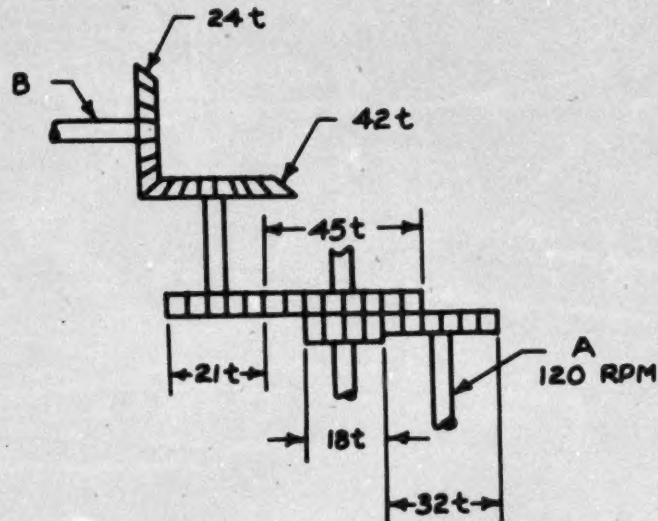


B. Problems without Complete Solutions (continued)

5. A workman desires to run a grinder 1,200 rpm. The shaft is belted to a 5" pulley on a motor running 1,800 rpm. How large a pulley should be installed on the grinder shaft?

Solution:

6. A machinist desires to increase the speed of shaft B to 1,000 rpm by changing the 32 tooth gear. How many teeth must the new gear have?



Solution:

7. What is the cost of 6 reamers if 8 reamers cost \$35.40?

Solution:

# RATIO AND PROPORTION

## Level 2

### Complete solutions to B problems

# Machine Tools

4.  $x$  = size of stock needed

$$\frac{x}{1 \frac{3}{4} \text{ in}} = \frac{2 \frac{1}{2} \text{ in}}{1 \frac{1}{2} \text{ in}}$$

$$x = \frac{(2.5)(1.75 \text{ in})}{1.5}$$

$$x = 2.92 \text{ in} \quad \text{therefore need 3 inch stock}$$

5.  $\frac{1,800 \text{ rpm}}{1,200 \text{ rpm}} = \frac{x}{5 \text{ in}}$

$$x = \frac{1,200 (5 \text{ in})}{(1,800)}$$

$$x = 7.5 \text{ in}$$

6.  $120 \text{ rpm} = (1,000 \text{ rpm}) \left( \frac{24 \text{ teeth}}{42 \text{ teeth}} \right) \left( \frac{21 \text{ teeth}}{45 \text{ teeth}} \right) \left( \frac{18 \text{ teeth}}{A} \right)$

$$A = \text{teeth in gear A} = \frac{(1,000 \text{ rpm}) (24) (21) (18 \text{ teeth})}{(120 \text{ rpm}) (42) (45)}$$

$$A = 40 \text{ teeth}$$

7.  $x$  = cost of 6 reamers

$$\frac{6 \text{ reamers}}{8 \text{ reamers}} = \frac{x}{\$35.40}$$

$$x = \frac{6(\$35.40)}{8}$$

$$x = \$26.55$$

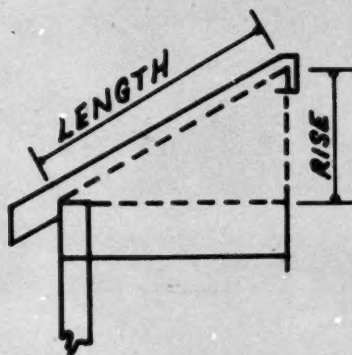
RATIO AND PROPORTION  
Level 2

Construction

B. Problems without Solutions

1. Find the length of the rafter if the span is 36 feet, and the pitch is  $5/8$ .

Note: One rafter covers  $1/2$  the span.



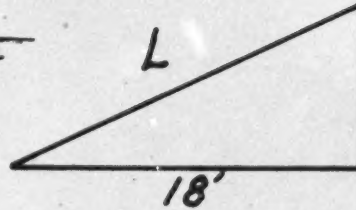


RATIO AND PROPORTION  
Level 2

Construction

Complete Solutions to B Problems

1. 
$$\begin{aligned} L &= \sqrt{(18')^2 + (45/4')^2} \\ &= \sqrt{(72/4')^2 + (45/4')^2} \\ &= \sqrt{(84.91/4')^2} \\ &= \sqrt{(21.23')^2} \\ &= 21.23' \\ &= 21' + (0.23 \text{ ft})(12 \text{ in/ft}) \\ &= 21 \text{ ft } 2 \frac{3}{4} \text{ inches} \end{aligned}$$



$$(18')(5/8) = 45/4 \text{ ft}$$



RATIO AND PROPORTION  
Level II

Drafting

B. Problems without solutions.

1. Concrete is a material composed of cement, sand and gravel or crushed rock and water mixed in various proportions. The proportions are generally expressed as volume ratio, thus, 1:2.5:4 means 1 part cement 2.5 parts sand, and 4 parts gravel by volume. The amount of water varies to give the desired consistency and strength of the concrete, and the quantity of water in a mix is expressed as so many gallons per sack of cement.

To determine accurately the amount of cement, sand and gravel required to make one cubic yard of concrete of a certain mix is a difficult problem and will not be attempted here.

However, Fuller's approximate rule can be used with sufficient accuracy to order material for a construction job.

Fuller's Rule

c = parts of cement

s = parts of sand

g = parts of gravel

C = number of bbls. of cement required for one cubic yard of concrete

S = number of cu. yds. of sand per cu. yd. of concrete.

G = number of cu. yds. of gravel per cu. yd. of concrete

Note: 1 barrel of cement = 4 bags cement

1 bag of cement weighs 94 lbs. and is considered to have a loose volume of 1 cu. ft for shipping purposes.

$$C = \frac{11}{c + s + g}$$

$$S = (C) (s) \left( \frac{3.8}{27} \right)$$

$$G = (C) (g) \left( \frac{3.8}{27} \right)$$

Note that in the ratio 3.8/27 the numerator, 3.8, is the actual number of cu. ft. in a barrel of cement. The ratio 3.8/27 then represents the actual number of cu yds in a barrel of cement.

$$1 \text{ bbl. cement} = 3.8 \text{ cu. ft.}$$

$$1 \text{ bbl. cement} = \frac{3.8}{27} = 0.141 \text{ cu. yd.}$$

Problem:

.75 cu. yd. of concrete of 1:2.5:4 mix is required for a job.  
How much cement, sand and gravel is required?

RATIO AND PROPORTION  
Level II

Drafting

Complete solutions to B problems.

1. The concrete mixture in one part cement, 2.5 parts sand and 4 parts gravel. Therefore, the total number of parts is:

$$1 \text{ part} + 2.5 \text{ parts} + 4 \text{ parts} = 7.5 \text{ parts}$$

So, the cement is  $1/7.5$  of the total concrete required.

$$= (1/7.5) (.75 \text{ cu yds})$$

$$= .1 \text{ cu yds}$$

The sand is  $2.5/7.5$  of the total required concrete

$$= (2.5/7.5) (.75 \text{ cu yds})$$

$$= .25 \text{ cu yds}$$

The gravel is  $4/7.5$  of the total required concrete

$$= (4/7.5) (.75 \text{ cu yd})$$

$$= .40 \text{ cu yds}$$